

# **From Agriculture to Technology: Science Policy in Zambia since Independence**

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## **Declaration**

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## Summary

The national innovation systems of developed countries have been studied and documented, but not much is known about the national innovation systems of developing countries. This is because most developing countries only recently turned their policy attention to national innovation systems and the associated support for science and industry. In addition, many of the indicators used to describe the national innovation systems of developed countries are not sufficiently documented in statistical form in developing countries.

Linsu Kim's technology trajectory framework was used to study the national innovation system of a developing country, namely Zambia, in order to determine if the country is moving from an exporter of raw materials to value addition using the existing national innovation system as compared to the previous one. This was achieved by the collection of science and technology indicators as defined in the Frascati Manual. In addition modifications to the collection of data as outlined by Jacques Gaillard were applied. Jacques Gaillard proposed strategies for defining the lack of data on many indicators relevant to describing a national innovation system in a developing country.

The study compares two eras of the *Zambian* national innovation system, namely that from 1964 to 1995 and from 1996 onwards. This split represents a shift from a command driven economy to a free market economy with an emphasis on innovation and value addition. The thesis focused on three sectors: agriculture, industry and science, as well as the relevant government institutions and ministries tasked with the management of science and technology in Zambia.

The thesis concludes by comparing the two innovation systems using Linsu Kim's adapted model and indicators in order to determine whether Zambia is indeed moving towards value addition (as stated in government policy announcements), and to investigate implications for the new science and technology policy currently in draft form.

## Opsomming

Die nasionale innovasie sisteme van ontwikkelde lande is reeds bestudeer en gedokumenteer, maar min is bekend oor die nasionale innovasie sisteme van ontwikkelende lande. Dit is so omdat die meeste ontwikkelende lande eers onlangs nasionale beleid oor innovasie sisteme en die gepaardgaande ondersteuning vir wetenskap en industrie probeer vestig het. Verder is baie van die indikatore wat gebruik word om die nasionale innovasie sisteme van ontwikkelde lande te beskryf, nie genoegsaam gedokumenteer in statistiese vorm in ontwikkelende lande nie.

Die tesis poog om met behulp van Linsu Kim se tegnologiese trajekraamwerk die tegnologiese trajek van 'n ontwikkelende land, naamlik Zambië, te bestudeer. Dit word gedoen deur wetenskaps- en tegnologie indikatore soos gedefinieer in die Frascati Handboek te versamel met verstellings soos voorgestel deur Jacques Gaillard oor hoe om die ontwikkelingspeil van lande te bepaal met te min beskikbare data oor die relevante indikatore.

Die studie vergelyk twee eras in die Zambiese nasionale innovasie sisteem, naamlik van 1964 tot 1995 en van 1996 tot op hede. Hierdie verdeling verteenwoordig 'n skuif vanaf 'n kommunistiese regering na 'n kapitalistiese sisteem met 'n klem op innovasie en waarde-toevoeging. Die tesis fokus op drie sektore: landbou, industrie, en wetenskap, sowel as die relevante regeringsinstellings en ministeries in beheer van wetenskap en tegnologie in Zambië.

Die tesis sluit af deur die twee innovasie sisteme te vergelyk met behulp van Linsu Kim se aangepaste model en indikatore om te probeer vastel of Zambië inderdaad besig is om te beweeg in die rigting van waarde-toevoeging (soos in regeringsbeleid aangekondig) en om implikasies vir die nuwe wetenskap en tegnologie beleid te ondersoek.

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# Chapter One

## Introduction

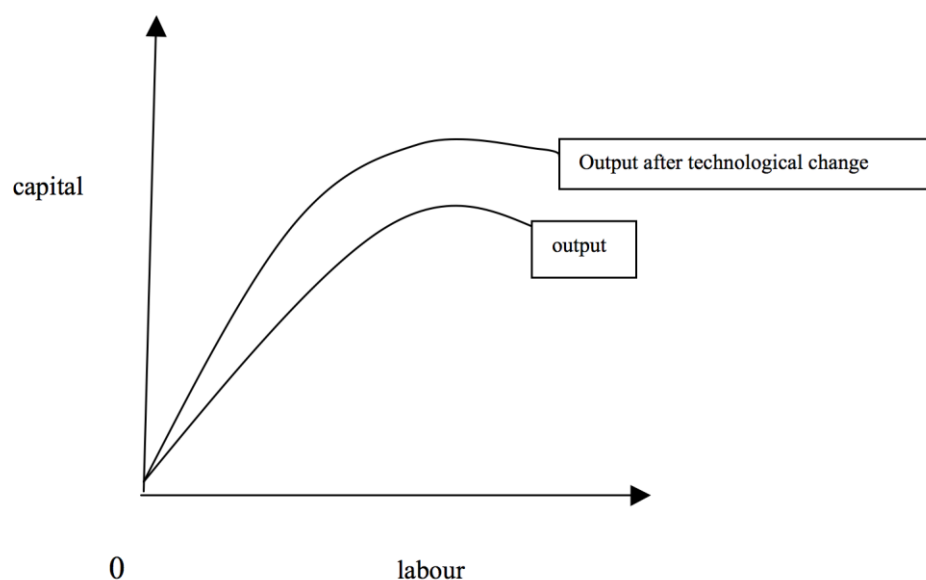
### 1.1 Background

Zambia is a landlocked country that is situated in Southern Africa. Although landlocked, the country has several lakes and rivers some of which are shared with neighbouring countries. The shared lakes and rivers include Lake Mweru and Lake Tanganyika in the North; Kariba Dam the second largest man made dam in Africa in the south and parts of the Zambezi River in the East. Lake Bangweulu in the North, Itzhi-tezhi Dam in the centre of the country, Luangwa river in the East and the Kafue River that runs from North to South of the country are not shared with any of its neighbours. Zambia is a former British colony (known then as Northern Rhodesia) that gained its independence in 1964.

At the time of independence, the country faced many challenges; among them were lack of skilled manpower, a dual economy in which the wealth was held by the minority white settlers and few manufacturing industries. Zambia is rich in mineral resources such as cobalt, copper, manganese, etc. and thus mining is a major economic activity and remains the mainstay of the Zambian economy to date. However, at the time of independence the country was primarily an exporter of raw materials. From the onset, the Zambian government recognised that to enable the country move from an exporter of raw materials to finished goods, science in particular research, would play a key role.

According to growth theories in macroeconomics, the role of technological advancement cannot be over emphasised. A simple illustration in economics is the production function which is written as:  $Y = F(K, L)$ , where  $Y$  is the amount of output as a function of the amount of capital ( $K$ ) and the amount of labour ( $L$ ). The production function reflects the amount of output that can be produced given an amount of capital and labour and given a certain level of available technology. However, an increase in the level of technology increases the amount of output that can be produced using the same amounts of capital and labour i.e. if someone invents a better way of producing an item, the result is more output from the same

amounts of inputs.<sup>1</sup> Thus technological change alters the production function and in turn leads to greater output i.e. GDP. For a developing country like Zambia, it is imperative that the technological advancement through scientific research be a priority to enable the country increase its output and help realise social and economic growth and eventually development.



**Figure 1: Economic Output and Technological Change**

A body of research since the 1980s tried to establish the role of science and technology in contributing to development and growth of national economies. The notion of a “National Innovation System” (NIS) is used in this literature to describe the interaction between technology policy and economic performance of advanced economies.<sup>2</sup> The question is, can this perspective also be applied to developing economies? The thesis will investigate the change in Zambia from a command economy to a market economy from the perspective of a national innovation system. The perspective of NIS is a third party perspective applied to policies and choices by the Zambian government. The Zambian government does not necessarily subscribe to this perspective in their policy making.

For the purposes of this analysis, two contrasting National Innovation Systems are identified corresponding to organizational and policy changes made by two different Zambian government regimes. The first ran from 1964 to 1995 and the second from 1996 to date. Government policy is constantly updated and a third policy exists that is currently in draft form. This could give rise to a third era therefore, for the purposes of the dissertation, the

<sup>1</sup> Mankiw NG. 2001. *Principles of Macroeconomics* 2<sup>nd</sup> Edition. Harcourt

<sup>2</sup> Freeman C. 1987. *Technology, policy, and economic performance: Lessons from Japan*. Pinter Publishers.

study ends in 2012. Once the two eras have been described from the perspective of national innovation systems, they will be compared using a technology trajectory framework that has been adapted from Linsu Kim who described the South Korean development experience. The adapted technology trajectory framework will be used to examine whether the changes in Zambia from one era to the other, has indeed put the economy on a trajectory moving from raw materials export to value addition.<sup>3</sup>

### **1.1.1 Science Sector**

In 1967 the Zambian government, having already understood the value of technology and scientific research and the positive effects on economic growth for the nation at large, established the National Council for Scientific Research (NCSR) through an act of parliament (Act No. 55 of 1967). The model was developed by the United Nations Educational, Scientific, and Cultural Organisation (UNESCO) to help developing countries manage scientific research and innovation.<sup>4</sup>

The then President, Dr. Kenneth Kaunda, announced his intention to set up the Council during the laying of the foundation stone for the University of Zambia in 1966. He emphasised the need for Zambia to work out a national programme of scientific research that had to be carried out in accordance with carefully thought out priorities and control of expenditure.<sup>5</sup>

The NCSR fell under the Office of National Development and Planning which developed the National Development Plans for all sectors of the economy for the whole country. The Council was tasked with, among other things, co-ordinating the science sector in Zambia and influencing research priorities in the development plans so as to achieve economic development. The Act that established the Council stipulated that the Chairperson was the Vice-President; it therefore occupied a very high position in the structure of government. To emphasize the importance of the institution, the President attended the first meeting of the Council.

At independence, the country had eighteen institutions carrying out research. This included the Research Branch of the Department of Agriculture established in 1952, the Central

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<sup>3</sup> Kim L. 1997. *Imitation to Innovation: The Dynamics of Korea's Technological Learning*. Harvard Business Press: United States of America

<sup>4</sup> Vitta PB. 1990. Technology policy in sub-Saharan Africa: Why the dream remains unfulfilled. *World Development*. 18(11): 1471-1480.

<sup>5</sup> National Council for Scientific Research. 1967. *Annual Report for National Council for Scientific Research*.

Research Station established in 1927 and the Central Fisheries Research Institute – Fisheries Research Division established in 1962. The three research institutions handled crop, animal and fisheries research and benefitted mainly the non-African farmers. The research institutions got the research funds from the NCSR once it was established; hence the institution coordinated all the research carried out in the country.

In 1996 the National Innovation System was revised with the coming of the National Science Policy of 1996. Though the NCSR was able to promote the science sector and carry out research very well, it was felt that it was not performing its advisory function well due to the weaknesses in its statutory linkages with other research institutions in the country.<sup>6</sup> The policy proposed the establishment of three separate institutions with separate functions.

The Act of 1997 established the National Science and Technology Council (NSTC) and the National Technology Business Council (NTBC). The main function of NSTC was to co-ordinate, regulate and promote the science sector. The main objective of NTBC was to commercialise both proven national and international technologies for the benefit of entrepreneurs and business communities. With the changes all research institutions were allowed to lobby central government directly for funds to carry out research.

In 2001 the Act that Established the NCSR was repealed and in its place was established the National Institute for Scientific and Industrial Research (NISIR) that took up the research mantle of the NCSR, including all assets and liabilities. All three institutions fell under the Ministry of Science, Technology and Vocational Training.

### **1.1.2 Economic Outlook**

From 1953 to 1963 Zambia was part of the Federation of Rhodesia and Nyasaland which consisted three countries namely Northern Rhodesia, Southern Rhodesia and Nyasaland (now known as Zambia, Zimbabwe and Malawi respectively). The federation was dissolved on the 31<sup>st</sup> of December in 1963 and in the following year, Northern Rhodesia gained its independence.

Zambia was integrated into the global economy as a raw materials provider. This led to Zambia primarily exporting raw materials such as minerals and agro products to be processed outside the country in Europe and Southern Rhodesia.

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<sup>6</sup> Ministry of Science, Technology and Vocational Training. 1996. *National Policy on Science and Technology*. Lusaka

At the time of independence the following were the challenges faced (Source: First National Development Plan):

1. The systematic draining of revenue from Northern Rhodesia for the benefit of Southern Rhodesia. The loss of revenue from Zambia in this manner over the life of the Federation was estimated at £60 to £70 million.
2. Concentration of industrial development in Southern Rhodesia, the role of a market being reserved for the northern territory.
3. Concentration in the field of education on providing facilities for European education, secondary education for Africans was held at a level far below requirements, while higher education was consciously impeded.
4. Concentration of Federal expenditure and effort in agriculture on extension services for non-Africans, extension services for African agriculture was entirely dependent on local, non-Federal funds.
5. Concentration of strategic common services - Central African Airways, Rhodesia Railways and Kariba power station, in Southern Rhodesia.

Industries that existed in the country at independence were mainly subsidiaries of Southern Rhodesian firms.<sup>7</sup>

The most serious handicap facing the nation at independence was a lack of trained manpower mainly due to the education policy at the time. The total number of Zambians with locally obtained school certificates was just over 1,200 and the number of Zambian graduates was scarcely 100. The absence of trained manpower affected the nation's ability to transform home resources supplemented by foreign resources, into social and economic growth.

Zambia at the time of independence presented a "dual economy" in the most extreme form, in the sense that inherited structures, from the colonial era, meant that economic activity was in the hands of a small privileged minority. The role of the mass of indigenous people was limited either to subsistence agriculture, or to provide a reserve of unskilled manpower, and a limited market for consumer goods. The aim of the government of the day was to increase the number of skilled manpower in the country and enable them participate more fully in the development of the nation.

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<sup>7</sup> Office of National Development and Planning. 1966. *First National Development Plan*. Government of Zambia. Lusaka, Zambia

The National Statistics Bureau conducted a detailed census in 1963 of the European population and a survey was also made of the number of Africans living in Zambia at the time. The survey estimated the African population to be 2,500,000. A more detailed census was carried out in 1965, and Zambia's population was found to be 3,712,100.<sup>8</sup>

As Table 1 shows Zambia had a very young population with 94% of the people being below the age of 60. This provided a young and vibrant work force to carry out the development plans outlined in the government's national policy documents. However the country still required a skilled work force, with only 0.03% of the population with a locally obtained school certificate and 0.002% of the population were Zambian graduates.

**Table 1 : Population ('000)**

		1965
A.	Population:	
	(i)      Zambian: Urban	764.2
	Rural	2866.0
	(ii)     Other	81.9
	<i>Total</i>	3712.1
B.	Age groups (Zambian only):	
	0 – 14 years	1637
	15 – 59 years	1861
	60 years and over	142
	<i>Total</i>	3630

<sup>8</sup> Office of National Development and Planning. 1966. *First National Development Plan*. Government of Zambia. Lusaka, Zambia

**Table 2: Gross Domestic Product (£m. - 1964 prices)<sup>910</sup>**

	1964
(i) Industrial Origin:	
a) Agriculture	9.1
b) Mining	118.8
c) Manufacturing	13.1
d) Construction	10.2
e) Commerce	22.5
f) Transport	10.3
g) Services	34.5
	<i>Total</i> 218.5
(ii) End Use:	
a) G.D.P. (factor cost)	218.5
b) G.D.P. (market prices)	228.5
c) Net factor payments abroad	-31.8
d) G.N.P.	196.7

The gross domestic product (GDP) for the year 1964 was £218.5 million. The mining sector accounted for 54% of GDP. Zambia was heavily dependent on copper which made the country susceptible to the rise and fall of copper prices. In addition the copper was exported as a raw material with no value addition. Table 2 shows the amount earned by the country per sector. The services industry was the next big earner for the country; it accounted for 15.8% of GDP. In comparison the agriculture sector accounted for 4.2% of GDP in 1964. The Gross National Product (GNP) of £196.7 million highlights the high earnings the country received.

At independence Zambia was earning some foreign exchange from manufacturing industries and agriculture though it was minimal. The long term goal was to diversify the economy from

<sup>9</sup> Office of National Development and Planning. 1966. *First National Development Plan*. Government of Zambia, Lusaka, Zambia

<sup>10</sup> Copper price in 1964 was £300 per ton

mining to agriculture. Table 3 and 4 show the gross output and value added by production for the mining, agricultural, and manufacturing sectors.

**Table 3: Agriculture and Lands (£m. - 1964 prices)**

	<i>Gross output, 1964</i>	<i>Value added, 1964</i>
Agriculture and Lands	12.7	9.2
Crops	8.0	5.6
Livestock	2.9	2.3
Fishing and hunting	0.6	0.4
Forestry	0.7	0.5
Other	0.5	0.4



**Table 4: Mining and Industry (£m. - 1964 prices)**

	<i>Gross output, 1964</i>	<i>Value added, 1964</i>
Mining and Quarrying	154.4	118.8
Manufacturing	33.8	13.1
Food	11.6	2.1
Beverages and Tobacco	6.2	2.8
Textiles and Clothing	1.6	0.6
Wood and Furniture	2.3	1.0
Paper and Printing	1.3	0.7
Rubber and Chemicals	1.5	0.7
Non-metallic Minerals	3.2	1.8
Metal and Machinery	5.9	3.2
Other	0.2	0.2
Construction	25.6	10.2
Electricity and Water	10.6	3.4

In 1964 the main agricultural exports consisted maize, groundnuts, tobacco, hides and skins.<sup>11</sup> Virginia tobacco was the most important export crop (by value) for the country amounting to 10,886.2 metric tonnes in 1964.<sup>12</sup>

Table 5 highlights the imports, exports and re-exports by sector for the year 1964. Manufactured goods classified chiefly by material were the highest domestic export by section. Beverages and tobacco were the highest in the agricultural sector at the time. The table shows that mineral exports contributed over 90% of the nation's foreign exchange supply. The country was heavily dependent on copper as a source of income.

<sup>11</sup> Ministry of Trade. 1967. *Annual Report for Ministry of Trade*

<sup>12</sup> Office of National Development and Planning. 1966. *First National Development Plan*. Government of Zambia. Lusaka, Zambia

The principal domestic exports (Table 6) for the country show tobacco as one of the highest earners in the agricultural sector. The biggest earner of foreign exchange was copper, lead, zinc and cobalt.

**Table 5: Imports, Domestic Exports and Re-exports by sections, Zambia 1964 (£'000)<sup>13</sup>**

	<i>Section</i>	<i>Imports</i>	<i>Domestic Exports</i>	<i>Re-Exports</i>
1	Food and live animals	7,132	697	113
2	Beverages and tobacco	1,445	2,939	79
3	Crude materials, in edible, except fuels	1,581	2,299	46
4	Minerals, fuels, lubricants and related materials	8,723	91	82
5	Animal and vegetable oils and fats	394	23	10
6	Chemicals	8,160	9	94
7	Manufactured goods classified chiefly by material <sup>14</sup>	17,222	156,489	394
8	Machinery and transport equipment	21,210	121	1,129
9	Miscellaneous manufactured articles	10,560	189	177
10	Miscellaneous transactions and commodities, not elsewhere specified.	1,792	579	2,199
	Total	78,219	163,436	4,323

According to the First National Development Plan, the two sectors that the country was relying on to diversify the economy was manufacturing and agriculture.

<sup>13</sup> Central Statistical Office. 1964. *Annual Statement of External Trade*. Lusaka.

<sup>14</sup> Includes cement, furs, building materials, copper, aluminium, lead and zinc among other things.

**Table 6: Principal domestic exports - 1964**

<i>Article</i>	<i>Unit</i>	<i>Quantity</i>	<i>Value</i>
Beef chilled	lb <sup>15</sup>	2,087,192	106,641
Fish, salted, dried or smoked	lb	6,242,855	178,357
Feeding stuff for livestock	lb	18,088,215	102,738
Tobacco, burley leaf	lb	3,787,866	302,540
Tobacco: flue-cured Virginia leaf	lb	22,323,852	2,428,800
Tobacco; Turkish leaf	lb	950,856	100,363
Cigarettes	lb	109,101	104,197
Railway sleepers (ties) wooden	cu. ft. <sup>16</sup>	363,950	168,487
Parquet blocks or strips roughly sawn	cu. ft.	414,903	203,840
Raw cotton	lb	1,022,903	109,341
Copper cobalt matte	tons <sup>17</sup>	1,609	128,489
Manganese ore and concentrates	tons	29,731	282,459
Copper slimes	centals <sup>18</sup>	35,055	755,839
Other old and scrap metal	centals	42,759	193,560
Precious and semi-precious stones, uncut	-	-	113,703
Copper, blister	tons	169,316	31,281,244
Copper electrolyte, wire bars	tons	512,495	103,067,141
Copper electrolyte, cathode form	tons	42,013	8,373,805
Copper electrolyte, bar and ingot	tons	27,643	5,628,241
Lead, bar and ingot	centals	295,170	1,140,612
Zinc, ingot bar and spelter	centals	1,011,378	4,865,013

<sup>15</sup> lb. pound = pound avoirdupois<sup>16</sup> Length: foot and yard = imperial standard foot and yard<sup>17</sup> Ton = 2,000lb<sup>18</sup> Cental = 100lb

Cobalt metal	tons	1,616	1,747,452
Balls, steel, for tube metals	centals	52,459	94,590
Footwear, mainly plastic materials	pairs	396,194	117,221
Emigrants effects, other	-	-	547,089
Other Domestic Exports			1,294,361
Total Domestic Exports			163,436,123

The tables above clearly show that Zambia as a country added very little value to goods exported and most of the products were exported as raw materials.

## 1.2 Problem

The draft Science, Technology and Innovation (STI) policy makes the following statement: “While exports have grown from US\$869 million to US\$5,099million between 2000 and 2008, the contribution of STI to these exports has been insignificant as is evidenced by Zambia’s continued export of raw materials, and in most cases with little value addition.”<sup>19</sup> Furthermore the draft (STI) policy states that “the science and technology sector has failed to respond to the needs above<sup>20</sup> because it is faced with several key challenges that can be categorised into:

- (a) Policy, legal and Institutional framework;
- (b) Human resource;
- (c) Infrastructure;
- (d) Commercialisation, transfer and diffusion of technologies
- (e) Indigenous Knowledge Systems
- (f) Funding;
- (g) Quality assurance;
- (h) Popularisation of Science and Technology”<sup>21</sup>

<sup>19</sup> Ministry of Science, Technology and Vocational Training. 2009. *Final Draft National Science, Technology and Innovation Policy*. Lusaka

<sup>20</sup> The STI policy lists and explains three sectors in “the needs above” namely agriculture, manufacturing and energy.

<sup>21</sup> Ministry of Science, Technology and Vocational Training. 2009. *Final Draft National Science, Technology and Innovation Policy*. Lusaka

It seems therefore as though the Zambian government expected that the restructuring of, and improved funding for, Science, Technology and Innovation should increase value-addition in the national economy. This raises the following questions that can be answered by comparing two policy eras regarding Science, Technology and Innovation in Zambia.

1. What has been the funding towards the STI sector from 1996?
2. Does the policy, legal and institutional framework affect the effectiveness of the sector?
3. Has Zambia continued to be primarily an exporter of raw materials with little to no value addition?

The thesis will seek to determine whether Zambia is indeed moving towards exporting of finished goods rather than raw materials under the existing policy regime in comparison with the previous era. To that end, a national innovation system perspective is brought to bear on the policy changes in Zambia and the two eras will be compared as two national innovation systems that have governed the research institutions that were set up, determining the way research has been funded, and have structured the science system in the country.

The first national innovation system corresponds with the communist era and the second with the market economy era. These two eras will be described from a national innovation system perspective in detail over the next chapters.

Figure 2 shows the innovation system from 1967, when the National Council for Scientific Research was set up, to 1996 when the new policy came into effect. The science policy of 1996 is still being used to this day while a new one is in draft form.

The NCSR occupied a high position in the structure of government with the chairman of the board being the vice president. The NCSR dispersed research grants from government, pointed out the direction of research in the country, carried out research and co-ordinated all research in the country. At the time Zambia being a command economy, the government controlled all major businesses.

Figure 3 shows the innovation system from 1996. The government arm that took up the mantle of coordinating and funding research was the National Science and Technology Council (NSTC), an agency that fell under the Ministry of Science, Technology and Vocational training. The country was now a mainly market driven economy with most businesses in the hands of the private sector.

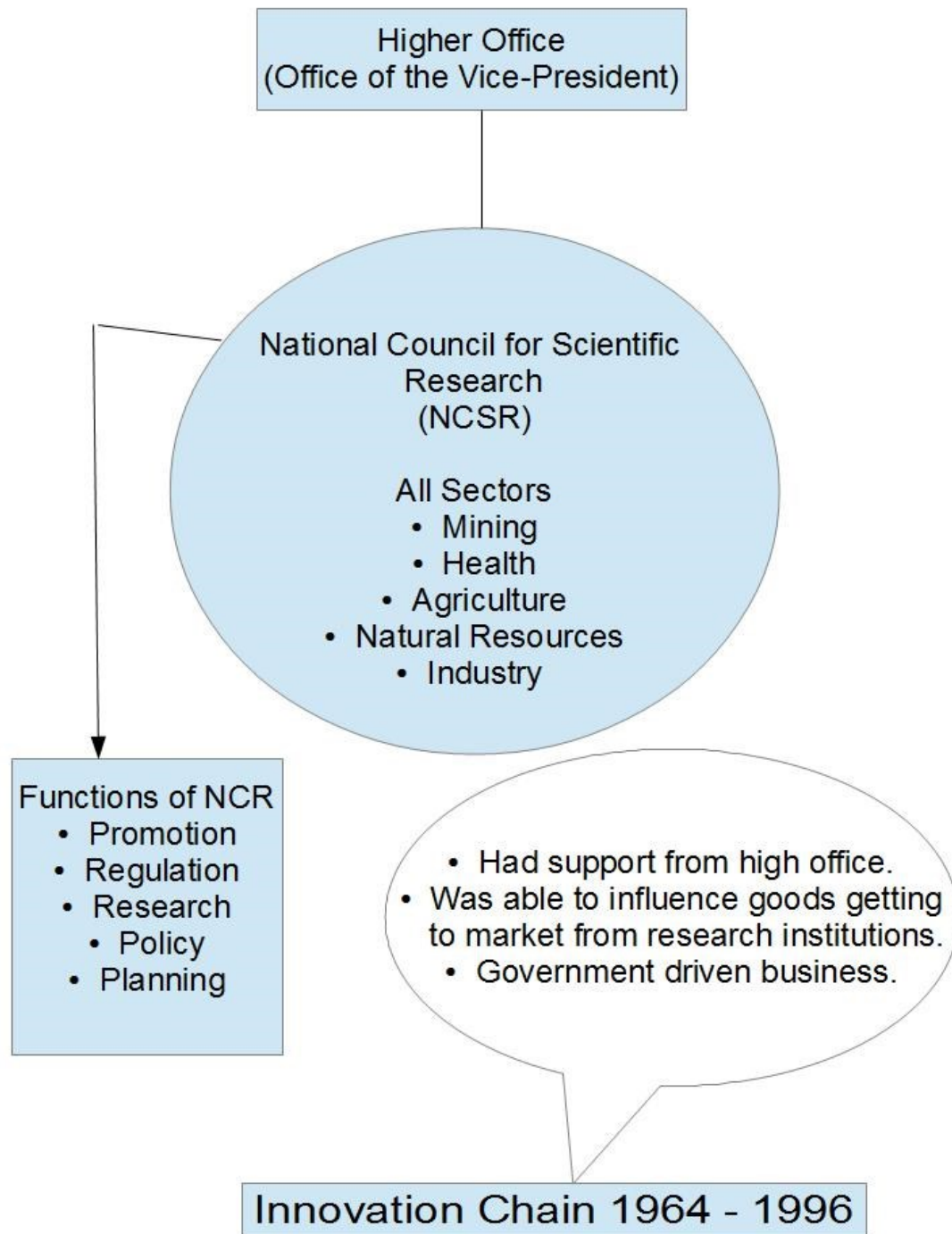


Figure 2: National Innovation System 1964 - 1996

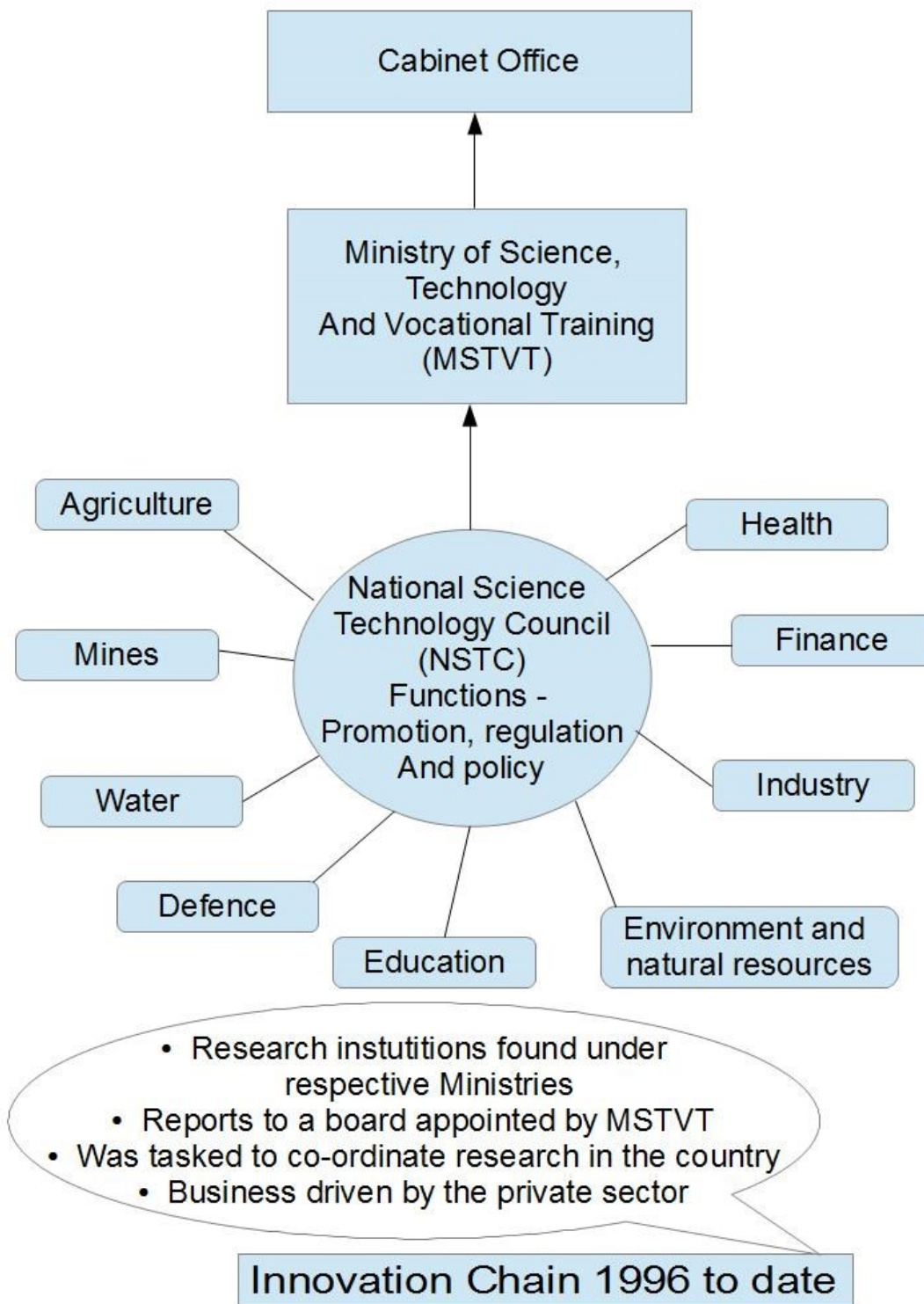


Figure 3: National Innovation System 1996 to date

### 1.3 Thesis Structure

After describing each of the national innovation systems, the performance of the two systems will be compared using Linsu Kim's technology trajectory framework. However, the data used for this comparison is not readily available and therefore the indicators normally used to describe OECD countries have to be augmented in some way.

To do this, the thesis is structured as follows:

Chapter two is a literature review that explains Freeman and Lundvall's notion of National Innovation Systems, which informs the later description and analysis of the two era's in the Zambian economy. However, since many of the indicators necessary for describing a National Innovation System in the way that Freeman or Lundvall does, are lacking in non-OECD countries, this description cannot be done exactly in the way that the Frascati Manual prescribes. For that reason, Jacques Gaillard's strategies for describing the development of countries with a lack of data on many indicators is explained, as these will be used to paint the picture of the two National Innovation Systems in Zambia and will be the basis for the comparison at the hand of Kim's framework.

Kim's framework that covers the broad trends of technological development of countries moving from a developing to developed state is also described in this chapter. Kim presents two analytical frameworks used to discuss the technology trajectory of Korea, namely, the technology trajectory framework, and the technology policy/strategy framework. The paper studies the development of Korea from a least industrialised nation to a technologically advanced nation using a technology trajectory. This thesis uses an adapted version of the technology policy/strategy framework to assess the two NIS that were identified in Zambia (Figure 4).<sup>22</sup>

Kim proposes that for a country to move to developing and innovative research they first need to assimilate already mature technologies as was the case with South Korea.

The technology policy/strategy framework has three perspectives.

1. *Market mechanism perspective.* This perspective targets policies designed to create needs for technology, increase science and technology capabilities and policies designed to link the two.

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<sup>22</sup> Kim L. 1997. *Imitation to Innovation: The dynamics of Korea's Technological Learning*. Harvard Business Press: United States of America.



2. *Technology flow perspective*. In this perspective government policies are analysed based on the flow of technologies into the country from abroad, the transfer of technology and the improvement of foreign technologies by local industries.
3. The *dynamic perspective* combines the two perspectives mentioned above to come up with a technology trajectory.

By taking already developed technologies, making them at a cheaper cost for industrialized nations and then copying and assimilating the technologies, countries such as South Korea developed at a very fast rate.

Collecting the data required to present this picture is a challenge in developing countries, like Zambia, with a lack of adequate and up to date statistical data. Jacques Gaillard proposes the use of descriptors and narratives to describe national research systems in developing countries. Descriptors include date of establishment of research institutions, number of research institutions, both private and public, and scientific corporation agreements. Under narratives Gaillard proposes the use of descriptors to highlight the strengths and weaknesses of the research system, and the role government and government agencies play in funding research. Additional science and technology indicators will be used including:

1. Government Budget Appropriations for R&D (GBAORD) expressed as a percentage of the total national budget.
2. Products that the country exported from 1964 to 2012.
3. Patents filed from 1964 to 2012.
4. The Gross Domestic Product (GDP) for the country from 1964.

As described in the Frascati manual.

In chapter three and four the data is presented according to the narratives and descriptors as proposed by Gaillard. Chapter three describes the first national innovation system from 1964 to 1996 while in chapter four the second national innovation system from 1997 to 2012 is presented. The data is presented in the following way:

1. Each chapter begins with narratives of the research system.
2. Policy documents in force under each era are described using indicators as sourced from the Frascati manual that are available to the researcher.

In chapter five the data collected is analysed based on Gaillard and Kim's frameworks. The two authors' theories will be used to present the picture of the two national innovation systems of the country (one from 1964 to 1996 and the other from 1997 to 2012).

In chapter six the Zambian situation (as expressed in chapter three and four) is explored in the light of Kim's broad trends and the conclusion is presented in chapter seven.

The policy documents used include the country's national development plans that were used from 1964 to 1993 as well as sector based policy documents that were introduced beginning 1994.

#### **1.4 Research Methodology**

In order to analyse the NIS of Zambia from 1964 to 2012 document analysis techniques will be used. The research will include various publicly available government documents, which include government budgets, policy documents, annual reports, national development plans and economic policy reports for the period under review, to conduct quantitative content analysis. The author selected this method for the following reasons:

1. The information would be difficult if not impossible to obtain from line ministries. It is not uncommon for requests for information to be refused, and if released it is glossed over or delayed.
2. To avoid bias from interviews. Personnel involved in the sectors to be studied, from researchers to government officials, have their own view (which may not necessarily be based on facts) of what is occurring in the science and technology field in Zambia. That is how much government funds the sector, research outputs and the products that the country exports.
3. In order to track the change over the time period - that is from 1964 to 2012.
4. More data can be obtained from document analysis compared to questionnaires or interviews and the data is more detailed from as far back as 1964.
5. The information is easily accessible from public, university and government libraries. The only necessary requirement is a letter from a researcher's supervisor attesting to the validity of the research and status of the researcher as a student.

Funding to the sectors being studied in the thesis will be analysed using the Government of Zambia Estimates of Revenue and Expenditure. The publication lists what Zambian

government intends apportion to the sectors for the year. The figures will be expressed as a percentage of GDP.

The products exported in the sectors under review will be obtained from the Central Statistical Office publication titled Annual Statement of External Trade. The publication is produced every year-end and lists the products exported by the country.

Collecting research and development indicators as indicated in the Frascati and Oslo Manual has proved a challenge in Zambia due to among many other reasons the scarcity of resources to undertake the exercise. There is a lack of up-to-date statistical information on science, technology and innovation.

In Zambia, the evaluation of the amount the government spends on research and development has proved difficult as no distinction is made between administrative costs and money spent on research. In addition most institutions do not have an official research budget. This is most apparent in universities where most lecturers spend most of their time teaching rather than on research.

Unlike in developed countries where the private sector funds and undertakes most of the R&D, in Zambia, the government accounts for a large percentage of R&D. It means therefore that public funds are the main source of funding research and development. The implication therefore is that research and development indicators as highlighted in the Frascati manual will be difficult if not impossible to collect. To that end Gaillard's recommendations for the collection of S&T indicators will be employed. In order to study the history of science policy in Zambia and determine if the country is moving from exporting raw materials to exporting finished goods, the following information will be collected and presented:

1. Products that the country exported from 1964 to 2012.
2. Patents filed from 1964 to 2012.
3. The Gross Domestic Product (GDP) for the country from 1964 to 2012.
4. Government Budget Appropriations for R&D (GBAORD). Ideally this involves identifying all the budget items involving R&D and measuring or estimating their R&D content.<sup>23</sup> However this would prove a problem in Zambia as money reserved for research and development institutions (this includes universities) is provided together with administrative costs. It would be impossible to tell how much goes to

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<sup>23</sup> OECD. 2002 *Main Science and Technology Indicators*. Paris

research if any at all. Therefore the assumption used is that all money going to research institutions will be added as going towards science and technology. It should also be noted that “these estimates, based on funders' reports, are less accurate than the "performer-reported" data but as they are derived from the budget, they can be linked back to policy issues. These breakdowns reflect policies at a given moment in time.”<sup>24</sup> Initial budget appropriations defined as “figures as voted by the parliament for the coming year, including changes introduced in the parliamentary debate”<sup>25</sup> will be used.

5. Government Budget Appropriations for R&D (GBAORD) expressed as a percentage of the total national budget. The significance of this ratio is that it provides an indication of the financial resources devoted to R&D in terms of the whole national budget.

In combination with the collected data the policies in the following sectors will be analysed

1. Agricultural sector
2. Industrial sector
3. Science sector (this will be limited to the institutions and ministries that manage science and technology for the Zambian government.)

Narratives of the history of science policy in the country, the strengths and weaknesses of the national research system, the role of government, and other government agencies in funding research will also be included. The study will also investigate descriptors such as date of establishment, number of public research institutes, which will include universities, the governance of science in the country and available policy documents.

The author studied the publications from World Economic Forum entitled World Competitive report.<sup>26</sup> The 12<sup>th</sup> pillar – Innovation – lists several sub headings and countries are ranked based on the score achieved. The thesis analyses the amount spent by government on research and development, however the World Competitive report includes information from private companies<sup>27</sup> in order to ascertain a countries ranking on the global competitive index. In that

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<sup>24</sup> OECD. 2002 *Main Science and Technology Indicators*. Paris

<sup>25</sup> OECD. 2002 *Main Science and Technology Indicators*. Paris

<sup>26</sup> Specifically 2006-2007, 2010-2011, 2014-2015, 2016-2017. The report is published annually.

<sup>27</sup> And is not exclusive to government spending.

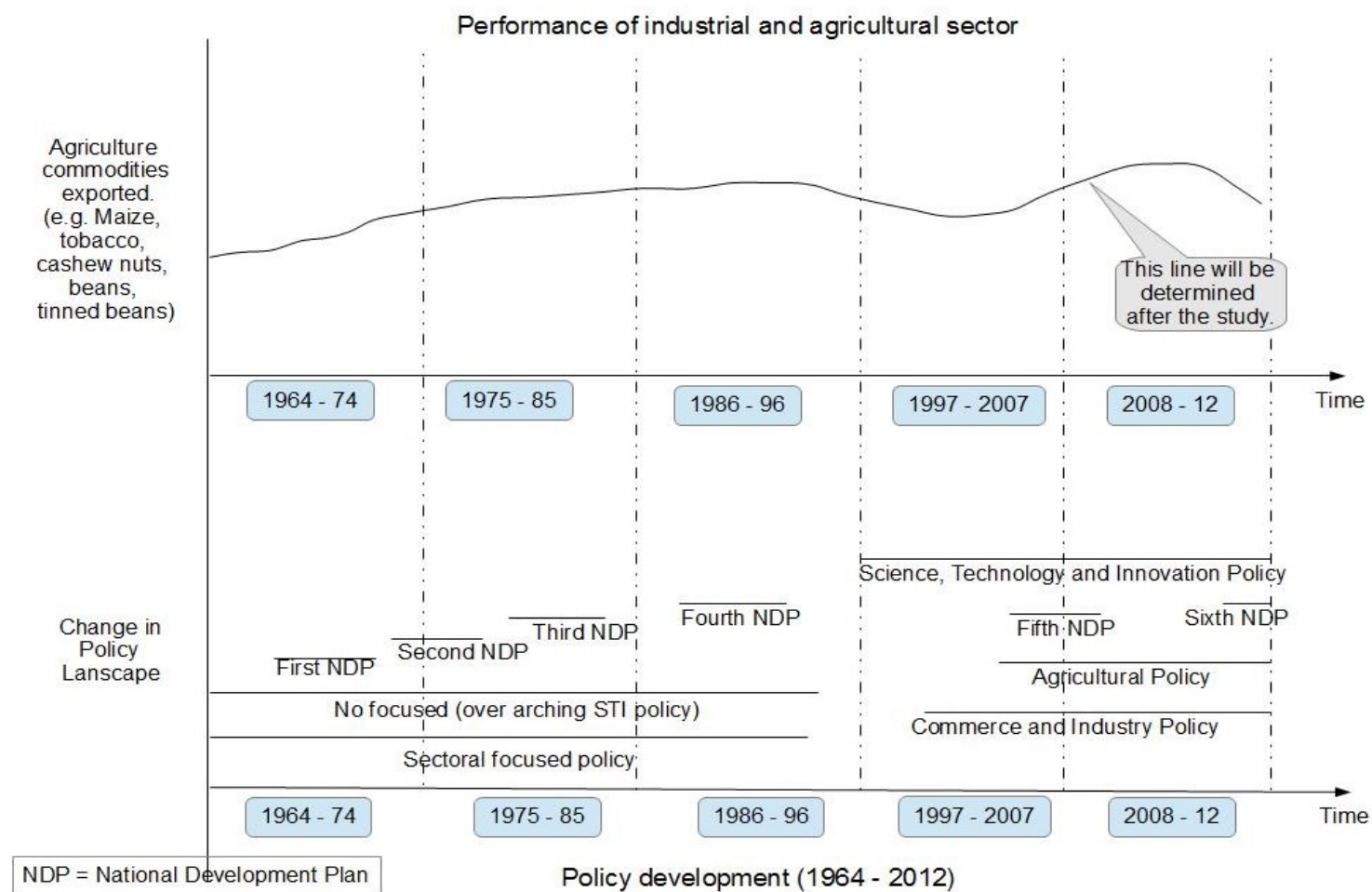
respect the author did not include the data from the report, as it would not have shown a true reflection of the Zambian governments spending on research and development.

### **1.5 Anticipation**

The trajectory of science and technology in Zambia is yet to be analysed. Questions such as how much does the country spend on research and development, is the amount increasing or decreasing, in what direction is the country moving in terms of technological advancement - are yet to be fully answered. The aim of this study is to explore the national innovation systems of Zambia to determine if the country is moving towards exporting of finished goods rather than raw materials using the existing innovation system as compared to the previous one.

The science policy includes many fields e.g. health, industry, agriculture, mines, defence, water, environment and natural resources. The thesis narrows the field of study by investigating the policies formulated for the agricultural and industrial sectors only, from 1964 through to 2012.

The technology trajectory of the country will be studied based on Gaillards theory on the collection of indicators for the least developed countries and Kim's technology trajectory. The researcher anticipates to find that Zambia has been steadily moving from an exporter of raw materials to value addition in the existing innovation system as compared to the previous one.



**Figure 4: Adapted Linsu Kim's model , it references the dynamic perspective<sup>28</sup>**

<sup>28</sup> Policy development includes introduction of new policies, revision and removal of policies

# *Chapter Two*

## Literature Review: National Innovation System Perspective

### 2.1 Introduction

Governments around the world have institutions that promote, fund and push science and technology research and innovation; the country's National Innovation System (NIS). Successful economic development is linked to a nation's capacity to acquire, absorb, disseminate, and apply modern technologies. This capacity is embodied in a nation's NIS—the complex of regulations, institutions, human capital, and government programs involved in the process of linking science and technology to the economy<sup>29</sup>. These institutions work to realise the government's policies.

The National Innovation System concept has been widely circulated and pushed to governments by world bodies such as the OECD, UNESCO, and the World Bank. The aim is to give policy makers and policy making bodies that are in charge of science and technology policy within government an analytical framework where innovation and learning are seen as important processes behind economic growth and welfare. It included elements that interact in shaping innovation processes as well as elements that link innovation to economic performance<sup>30</sup>.

The word system as used in NIS refers to different actors, be they government institutions, organisation, institutions of learning, industries and all other organisations that play a part in bringing innovations and new knowledge to market or the people.

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<sup>29</sup> Bozeman B, Gaughan M, Sampat B. 2003. Knowledge Flows and Knowledge Collectives: Understanding the Role of Science and Technology Policies in Development. *A Project for the Global Inclusion Program of the Rockefeller Foundation*. New York. p.4.

<sup>30</sup> Lundvall BA. 2007. National Innovation Systems – Analytical Concept and Developmental Tool. *Industry and Innovation*. 14(1): 95-119.

On the other hand innovation can be defined as “continuous cumulative process involving not only radical and incremental change but also the diffusion, absorption and use of new products or systems.”<sup>31</sup>

The definitions of a National Innovation System as found in Feieson S.<sup>32</sup> include:

“... The national institutions, their incentive structures and their competencies, that determine the rate and direction of technological learning (or the volume and composition of change generating activities) in a country” (Patel and Pavitt, 1994)

“... The set of institutions whose interactions determine the innovation performance of national firms.” (Nelson and Rosenberg, 1993)

“... The network of institutions in the public- and private-sectors whose activities and interactions initiate, import, modify and diffuse new technologies” (Freeman, 1987)

“... The national system of innovation is constituted by the institutions and economic structures affecting the rate and direction of technological change in the society” (Edquist and Lundvall, 1993).

Source: Niosi, 2002, p.292

**Box 1: Definitions of National Innovation Systems**

National Innovation Systems in individual countries constitute a broad range of institutions and firms, however the basic actors are illustrated in the figure below. For an economy to succeed it has to be characterised by learning, a willingness to absorb, digest and apply the knowledge gained.

<sup>31</sup> Johnson B, et al. 2004. Economic development and the national system of innovation approach. *Proceedings of the First Globalics Academy*, Ph.D. School on National Systems of Innovation and Economic Development, Lisbon, Portugal 25 May - 4 June 2004.

<sup>32</sup> Feinson S. 2003. National Innovation Systems Overview and Country Cases, *Knowledge flows and knowledge collectives: understanding the role of science and technology policies in development*. (1): 13-38



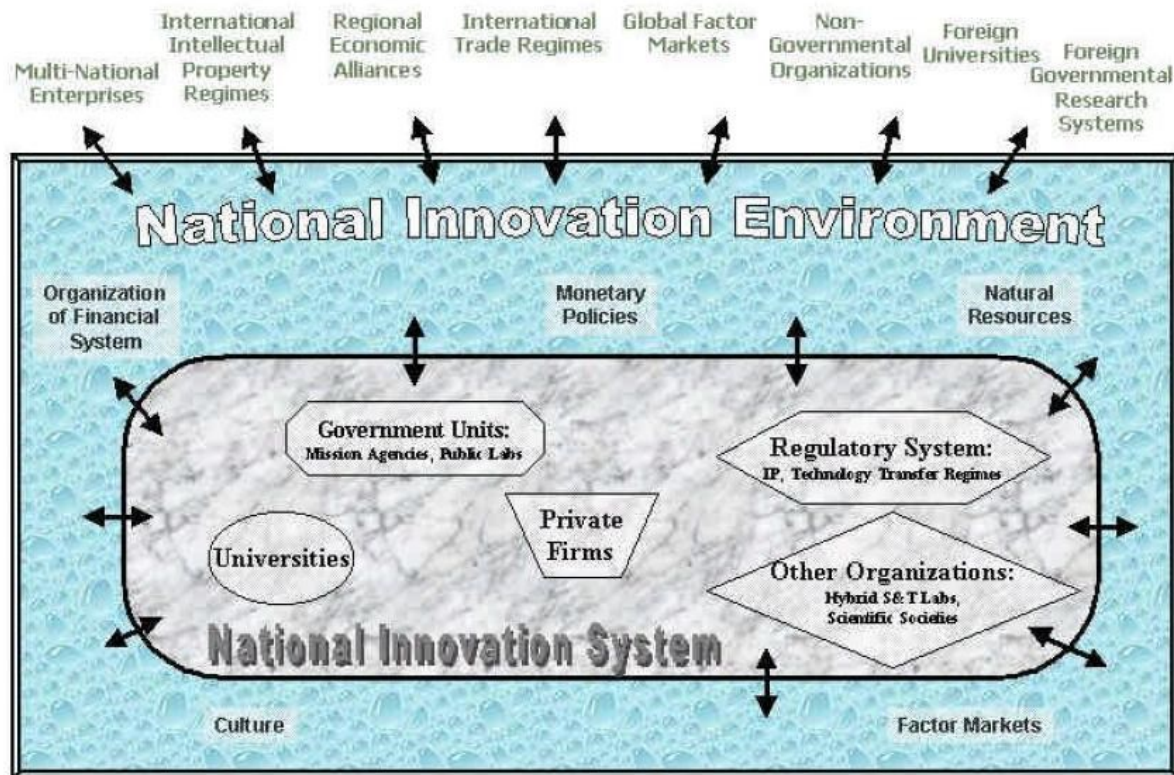


Figure 5: Global Innovation Environment<sup>33</sup>

Using Kim's model the thesis will aim to analyse the science and technology, agricultural, trade and industrial policies of Zambia to determine if the country is moving from an exporter raw materials to value addition using the existing national innovation system as compared to the previous one. In this thesis the term national innovation system will refer to the institutions that interact in the science technology and innovation sector. The dissertation will study public institutions and the policies that govern them to determine the country's performance, using Linsu Kim's adapted technology trajectory framework.

## 2.2 Kim's Research

Kim's analytical framework comprises a technology trajectory framework, a technology policy strategy framework and the dynamic perspective which combines the two frameworks. The frameworks can be used to analyse technology policies in developing countries.

In Kim's work "technology refers to both a collection of physical processes that transforms inputs into outputs and knowledge and skills that structure the activities involved in carrying

<sup>33</sup> Bozeman B, Gaughan M, Sampat B. 2003. *Knowledge Flows and Knowledge Collectives: Understanding the Role of Science and Technology Policies in Development*. . A Project for the Global Inclusion Program of the Rockefeller Foundation. New York. p.6

out these transformations. Technology is the practical application of knowledge and skills to the establishment, operation, improvement and expansion of facilities for such transformations and to the designing and improving of outputs.”<sup>34</sup> “Technology capability [is defined as] the ability to make effective use of technological knowledge in efforts to assimilate, use, adapt and change existing technologies”<sup>35</sup>

Two different types of technology trajectory frameworks are combined as shown in figure 6. The top graph shows the innovation trajectory of industrially advanced countries. As can be seen the rate of product innovation<sup>36</sup> at the beginning of a new technology is high, while the rate of process innovation<sup>37</sup> is low (fluid state). Over time the rate of product innovation goes down as a more standard product is accepted on the market. In contrast, the rate of process innovation goes up as companies try to reduce costs by streamlining the way the product is made (transition state).

Over time process innovation dwindles as little innovation can be realised from current processes (specific state). It is at this point that companies look to catching up countries where labour costs are low to transfer the manufacturing process. This is so that companies can maximise profits and keep the prices of manufactured goods low. Hence industries in developed countries develop along a technology trajectory made up of three stages namely fluid, transition and specific. The top part of figure 6 illustrates the development of industries in industrially advanced countries.

In catching up countries, development moves from acquisition to assimilation and finally to improvement. As Kim puts it, “Industries in developing countries acquire mature technologies. In the beginning, the main task of the industries is assembly with little to no

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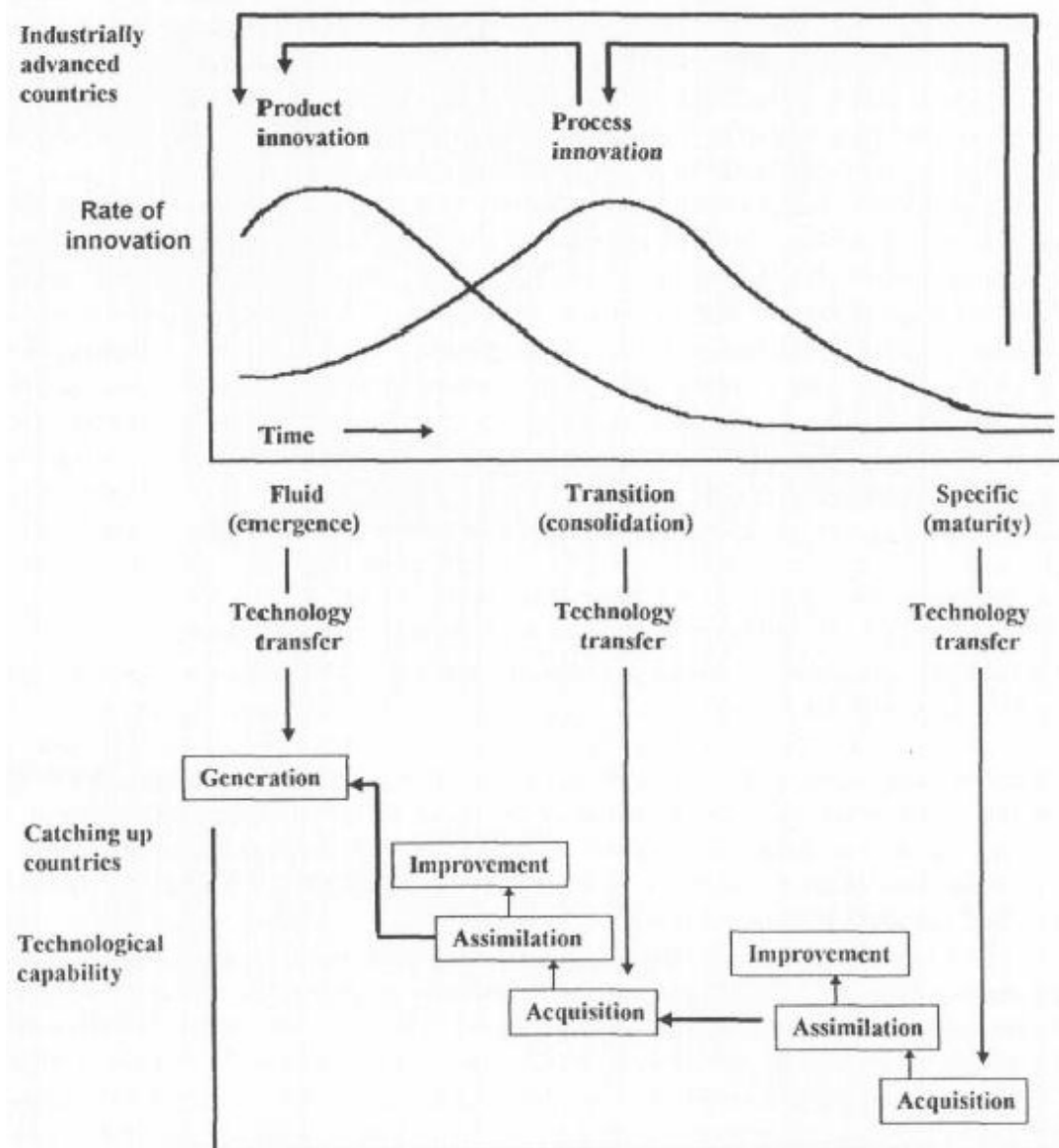
<sup>34</sup> Kim L. 1997. *Imitation to Innovation: The dynamics of Korea's Technological Learning*. Harvard Business Press: United States of America.

<sup>35</sup> Kim L. 1997. *Imitation to Innovation: The dynamics of Korea's Technological Learning*. Harvard Business Press: United States of America.

<sup>36</sup> A product innovation is the introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses. This includes significant improvements in technical specifications, components and materials, incorporated software, user friendliness or other functional characteristics. Definition obtained from OECD, 2005, “The Measurement of Scientific and Technological Activities: Guidelines for Collecting and Interpreting Innovation Data: Oslo Manual, Third Edition” prepared by the Working Party of National Experts on Scientific and Technology Indicators, OECD, Paris, para. 156.

<sup>37</sup> Process innovation is the implementation of a new or significantly improved production or delivery method. This includes significant changes in techniques, equipment and/or software. Definition obtained from OECD, 2005, “The Measurement of Scientific and Technological Activities: Guidelines for Collecting and Interpreting Innovation Data: Oslo Manual, Third Edition” prepared by the Working Party of National Experts on Scientific and Technology Indicators, OECD, Paris, para. 163.

improvement. But as competition increases, it leads to assimilation of indigenous technical efforts into the improvement of the technologies. Increased capability of local personnel, improved production technology and emphasis placed on export promotion leads to gradual



improvement of mature technologies.”<sup>38</sup> Catching up countries are eventually able to generate their own technologies through investment in research, development and engineering. The

**Figure 6: Linsu Kim's technology trajectory model**

bottom half of figure 6 illustrates this.

The technology trajectory model shown (figure 6) combines the two trajectories to show technology development in industrially advanced countries and catching up countries. It

<sup>38</sup> Kim L. 1998. Technology Policies and Strategies for Developing Countries: Lessons from the Korean Experience. *Technology Analysis and Strategic Management*. 10(3): 311-324.

shows that once countries are successful in the specific stage at assimilating and improving the technologies their objective will be to achieve the same in the transition and fluid stages. Each state requiring more research, development and engineering and a more knowledgeable human resource as higher level technologies are assimilated. Therefore developing countries reverse the direction of the technology trajectory of advanced countries.<sup>39</sup>

The technology policy/strategy framework answers the question - what can governments do in developing countries to enhance technological learning through technology policy.<sup>40</sup>

Technology policy may be analysed from three different views namely market mechanism, technology flow and time. In the *market mechanism perspective* policies related to technology development are analysed based on

1. Policies designed to create market needs for technology (demand) – usually referred to as the industrial policy.
2. Policies designed to increase the science and technology capabilities of the country (supply) – the science and technology policy.
3. Policies designed to create effective linkages between the two.

A competitive market is required for companies to invest in innovation. Therefore science and technology policies should be designed to work well with industrial policies which form the structure of the market and industrial development. Good management of the research and development system would be required to effectively link technology demand and supply.

*Technology flow perspective.* In this perspective government policies related to technology development are analysed based on the flow of technologies. The three key sequences are

1. The transfer of technology from abroad to local firms through policy instruments such as foreign direct investment, acquisition of foreign licenses, the setting up of manufacturing plants, and technical services.
2. The effective diffusion of imported technologies. If the original importer is the only one producing the technology over a period of time which could create a monopoly. In order to benefit the economy the technology has to be taken up by many industries (diffusion of the imported technology).

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<sup>39</sup> Kim L. 1998. *Technology Policies and Strategies for Developing Countries: Lessons from the Korean Experience*. Technology Analysis and Strategic Management .10(3): 311-324.

<sup>40</sup> Kim L. studied the development of Korea from a least developed nation to a middle income status.

3. In the third stage the country begins to produce copies of the technology and eventually improve on it. “This ability can only be acquired through indigenous technological effort. Local endeavours can include self-directed attempts to copy or reverse-engineer foreign products and processes, those aimed at improving and adapting previously acquired technology, and one’s own research and development. Such efforts become increasingly important as industrialization progresses.”<sup>41</sup>

The *dynamic perspective* (figure 8) combines the two perspectives mentioned above to come up with a technology trajectory. As written in Kim’s book *Imitation to Innovation* “The dynamic perspective dimension is added as the third dimension to indicate time. The relative impact of the individual sequences of technology flow and the impact of different types of market mechanisms – demand, supply, and linkage – change as an industry advances through

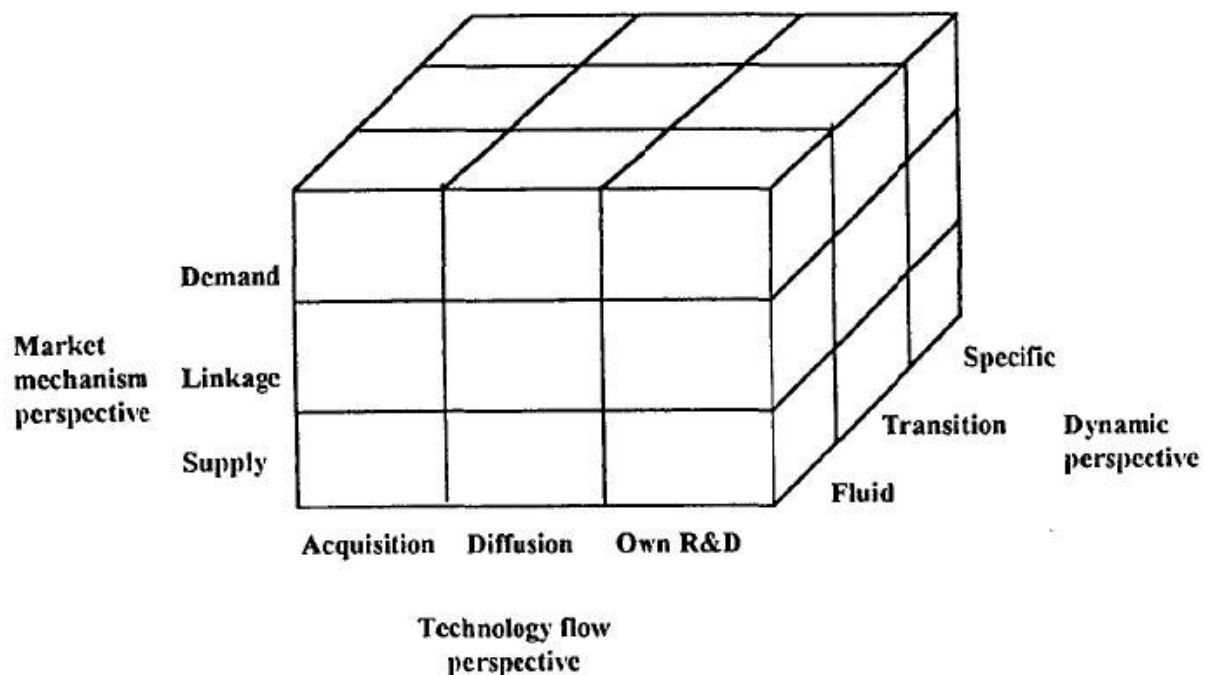


Figure 7: An Integrative Framework (Source Kim 1998)  
different stages of development over time.”<sup>42</sup>

### 2.3 History of National Innovation Systems Perspective

The concept “National Innovation System” was developed by Freeman<sup>43</sup> and Lundvall.<sup>44</sup> It was developed as an explanation to the reason why national growth rates differ, that is,

<sup>41</sup> Kim L. 1997 *Imitation to Innovation: The dynamics of Korea’s Technological Learning*. Harvard Business Press: United States of America

<sup>42</sup> Kim L. 1997 *Imitation to Innovation: The dynamics of Korea’s Technological Learning*. Harvard Business Press: United States of America



because they have different research systems. The concept was developed further by Lundvall<sup>45</sup>, Nelson<sup>46</sup> and Edquist<sup>47</sup>.

However, the first economist to write about how a country moved from least developed economy to a developed one, was Fredrich List.<sup>48</sup> The concept of national systems of production and learning was focused on the development of productive forces rather than on allocation of scarce resources.<sup>49</sup> He pointed out the need for infrastructure development and institutions that would cultivate specialized and learned people. He said the most important resource was people's mental capabilities (or intellectual) and wrote about the need to protect infant industries until they could compete with Britain.

List wrote about how Germany overtook England in terms of development. The German government was sending scientists to Britain and the USA to acquire knowledge on how to develop and maintain machinery. When they returned they were able to develop the same tools, if not better than, their British and American counterparts. It should be noted that though the modern version of innovation system concept was not developed by List, Freeman and Lundvall credit him as the intellectual ancestor.

Schumpeter is credited as the founder of modern innovation research. He recognises the entrepreneur as an individual who brings innovations to market and thereby generates employment. In his book *The Theory of Economic Development*<sup>50</sup>, after the creators of technologies, follow the imitators and bit by bit the profits created by the original wave of innovation are no longer there. This then leads companies in developed nations to source cheaper places in which to manufacture as described in Kim's technology trajectory framework.

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<sup>43</sup> Freeman C. 1982. "Technological infrastructure and international competitiveness," draft paper submitted to the OECD Ad Hoc Group on Science, Technology and Competitiveness, August 1982, mimeo.

<sup>44</sup> Lundvall BÅ. 1985 *Product Innovation and User-Producer Interaction*. Aalborg, Aalborg University Press.

<sup>45</sup> Lundvall BÅ. (Ed.) 1992. *National Innovation Systems: Towards a Theory of Innovation and Interactive Learning*. London, Pinter Publishers

<sup>46</sup> Nelson RR. (Ed.) 1993. *National Innovation Systems: A Comparative Analysis*. Oxford, Oxford University Press.

<sup>47</sup> Edquist C. (Ed.) 1997. *Systems of innovation: Technologies, institutions and organizations*. London, Pinter Publishers.

<sup>48</sup> Lundvall BÅ, Et Al. 2002. National systems of production, innovation and competence building. *Research policy*, 31(2), 213-231.

<sup>49</sup> Lundvall BÅ, Et Al. 2002. National systems of production, innovation and competence building. *Research policy*. 31(2): 213-231.

<sup>50</sup> Schumpeter J. 1934. *The Theory of Economic Development: An Inquiry into Profits, Capital, Credit, Interest, and the Business Cycle*. Transaction Publishers.

During the 1950s and 1960s, the evidence accumulated that the rate of technical change and of economic growth depended more on efficient diffusion than on being first in the world with radical innovations and as much on social innovations as on technical innovations.<sup>51</sup>

In his next body of work *Capitalism, Socialism and Democracy*<sup>52</sup> the innovation mechanism that Schumpeter presents is quite different. Here the major source of innovation is not the brave individual entrepreneur but the big company with experts working together in R&D teams searching for new technological solutions.<sup>53</sup>

The term National Innovation Systems was first used in Freeman's book. *Technology policy and economic performance: Lessons from Japan*.<sup>54</sup> The NIS is a narrow perspective and is interested in how innovation takes place rather than to maximize the amount of innovation. It is concerned with linking innovation and macroeconomic performance and aimed at mapping indicators of national specialization and performance with respect to innovation, research and development efforts and science and technology organizations.<sup>55</sup> The broader approach National Systems of Innovation takes into account social institutions, macro-economic, regulation of financial systems, education and communication infrastructures and market conditions as far as these have impact on learning and competence building process.<sup>56</sup>

The emphasis on national systems in this perspective is controversial in the face of global economic policies because regional groupings direct policies and strategies rather than individual countries. Countries can no longer use protectionist policies to protect fragile industries until they are mature, instead it has been suggested that "regional systems of innovation" or "technological systems" or "sectoral systems of innovation" are considered instead. Regional groupings are able to influence global policies better than individual countries especially in the twenty first century. However it has been argued by Porter<sup>57</sup> and

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<sup>51</sup> Freeman C. 1995. The "National System of Innovation" in Historical Perspective. *Cambridge Journal of economics*. 19(1): 5-24.

<sup>52</sup> Schumpeter J. 1942. *Capitalism, Socialism and Democracy*, 2<sup>nd</sup> ed. George Allen & Unwin, Ltd., London.

<sup>53</sup> Lundvall BÅ. 2007. Innovation System Research and Policy. Where it came from and where it might go. In *CAS seminar*, Oslo (Vol. 4).

<sup>54</sup> Lundvall BÅ. 2007. Innovation System Research and Policy. Where it came from and where it might go. In *CAS seminar*, Oslo (Vol. 4).

<sup>55</sup> Lundvall BÅ, Et Al. 2009. Bridging innovation system research and development studies: Challenges and research opportunities. *7th Globelics Conference*, Senegal.

<sup>56</sup> Gu S, Lundvall BA. 2006. China's innovation system and the move toward harmonious growth and endogenous innovation. *Innovation: Management, Policy & Practice*. 8(1): 1-26.

<sup>57</sup> Porter ME. 1990. The Competitive Advantage of Nations. *Harvard business review*. 68(2): 73-93

Lundvall<sup>58</sup> that the national entity cannot be disregarded in its entirety because national governments still make policies based on the countries interest despite what the global or regional policies dictate, Brazil, China and India are a case in point. Countries can still take an alternative direction to the regional decisions and National Innovation Systems as studied in this context are tailored to suit individual countries. In addition innovation systems at the national level can easily be studied and compared with that of regional systems.

As Micheal Porter puts it: “In a world of increasing global competition, nations have become more, not less, important. As the basis of competition has shifted more and more to creation and assimilation of knowledge, the role of the nation has grown.”<sup>59</sup>

Other authors<sup>60 61 62</sup> argue that systems of innovation should be considered in terms of the different functions that institutions or organizations perform. Edquist lists ten functions namely: provision of research and development, competence building, formation of new product markets, articulation of needs from the demand side of products, creation and change of organizations, networking between or within organisations in order to share knowledge, creation and change of policy frameworks and laws, incubating activities, financing innovation, and consultancy services.<sup>63</sup> Therefore organisations within the innovation system would then fall under a specific function. This would reduce the ‘barrier for further progress toward a more ‘rigorous’ and ‘theoretical’ concept’ as ‘the lack of agreement on where to draw the lines around the innovation system makes the concept ‘diffuse’ and causes a ‘lack of clarity’<sup>64</sup>.

This argument has been used to muster and bolster the National Innovation Systems perspective. However Lundvall says,

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<sup>58</sup> Lundvall BÅ, Et Al. 2009. Bridging innovation system research and development studies: Challenges and research opportunities, *7th Globelics Conference*, Senegal.

<sup>59</sup> Porter M. E. 1990. The Competitive Advantage of Nations. *Harvard business review*. 68(2): 73-93.

<sup>60</sup> Edquist C. 2005. Systems of innovation: perspectives and challenges. . *African Journal of Science, Technology, Innovation and Development*. 2(3): 14-43.

<sup>61</sup> Johnson A, Jacobson S. 2003. The Emergence of a Growth Industry: A Comparative Analysis of the German, Dutch and Swedish Wind Turbine Industries. In *Change, transformation and development*, pp. 197-227. Physica-Verlag HD.

<sup>62</sup> Liu X, White S. 2001. Comparing innovation systems: a framework and application to China's transitional. *Research policy*. 30(7): 1091-1114.

<sup>63</sup> Edquist C. 2005. Systems of innovation: perspectives and challenges. *African Journal of Science, Technology, Innovation and Development*. 2(3): 14-43.

<sup>64</sup> Lundvall BÅ, Et Al. 2009. Bridging innovation system research and development studies: Challenges and research opportunities. *7th Globelics Conference*, Senegal.



“But to conclude that agreeing on such a list is the most useful way to ‘create rigour’ and scientific progress might not be correct. Several other activities/functions/factors influencing innovation could be listed (five candidates that might enter the top ten as ‘factors influencing innovation’ are: competition, openness to international trade and capital flows, labour market dynamics, social welfare systems and ‘social capital’). Saying that further research will help us converge on the right ones is not a useful response to this selection problem.”<sup>65</sup>

This is not to say that the regional, sectoral or functional views were disregarded. Rather, the analytical levels at which innovation systems are viewed can be complimentary in the sense that each system can bring a different understanding and insight to the concept of systems of innovation.

Learning and education is a very important aspect in this perspective both science based learning and experience based learning, also social policies, the functioning of labour markets and the organisation of firms. A number of authors (Viotti<sup>66</sup> and Mathews<sup>67</sup>) maintain that the concept “learning system” should be used instead of “innovation system”. In particular Viotti argues that innovation system should be reserved for developed countries where the leading firms introduce innovations that are new for the world. In less developed countries incremental innovation, diffusion and learning may take place but not innovation (stricto sensu).<sup>68</sup>

But the aim of the concept of innovation systems is to identify the rate of diffusion rather than which industrialized nation is the first in the world with an innovation, as Freeman puts it: the rate of technical change and of economic growth depended more on efficient diffusion than on being first in the world with radical innovations and as much on social innovations as

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<sup>65</sup> Lundvall BÅ, Et Al. 2009. Bridging innovation system research and development studies: Challenges and research opportunities. *7th Globelics Conference*, Senegal.

<sup>66</sup> Viotti, EB. 2002. National Learning Systems: A new approach on technological change in late industrialising economies and evidence from the cases of Brazil and South Korea. *Technological Forecasting & Social Change*. 69(7), 653-680.

<sup>67</sup> Matthews JA. 1999. “From national innovation systems to national systems of economic learning: the case of technology diffusion management in East Asia”. Paper submitted to *DRUID Summer conference National Innovation Systems, Industrial Dynamics and Innovation Policy, Rebild, Denmark, June* pp 9–12.

<sup>68</sup> Lundvall BÅ, Et Al. 2009. Bridging innovation system research and development studies: Challenges and research opportunities. *7th Globelics Conference*, Senegal.

on technical innovations.<sup>69</sup> It seeks to identify how innovation takes place and how it is transformed into macroeconomic performance.

The study of the NIS concept is still at an early stage; however the study of NIS in developing countries is at an even more primitive stage<sup>70</sup>. The use of this theory for developing countries does have its detractors. Some authors, Lall and Pietrobelli<sup>71</sup>, argue for the use of the term National Technological System when referring to sub-Saharan African countries. They argue that

In developing countries, the main function of R&D is to master, adapt and improve imported technologies; [and] only at some relatively mature stage does it become truly innovative. Moreover, in most developing countries industrial enterprises conduct only a small fraction of total R&D; public institutions are responsible for the bulk, often in isolation from the productive sector.<sup>72</sup>

Furthermore

The way in which knowledge is used differs with the level of development. In mature industrial countries, the competitive use of technology is largely a matter of innovation – the ability to create new products and processes. In developing countries, it is more a matter of building the ability to use existing technologies at competitive levels of cost and quality.<sup>73</sup>

However Lundvall has a different viewpoint though he does agree with the analysis to a certain extent. In his 2007 paper published in the *Industry and Innovation* journal Lundvall writes:

I would argue that the broader understanding of innovation as including the diffusion, adaptation and use of new technology, proposed here, would make it less necessary to develop an alternative terminology for less developed countries.

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<sup>69</sup> Freeman C. 1995. The “National System of Innovation” in Historical Perspective. *Cambridge Journal of economics*. 19(1): 5-24.

<sup>70</sup> Intarakumnerd P, Et Al. 2002. National innovation system in less successful developing countries: the case of Thailand. *Research policy*. 31(8): 1445-1457.

<sup>71</sup> Lall S, Pietrobelli C. 2005. National technology systems in sub-Saharan Africa. *International Journal of Technology and Globalisation* 1(3): 311-342.

<sup>72</sup> Lall S, Pietrobelli C. 2005. National technology systems in sub-Saharan Africa. *International Journal of Technology and Globalisation* 1(3): 311-342.

<sup>73</sup> Lall S, Pietrobelli C. 2005. National technology systems in sub-Saharan Africa. *International Journal of Technology and Globalisation*. 1(3): 311-342.

Second it might be virtually impossible to gather data on what goes on inside firms through surveys and register data may also be scarce and unreliable. The standard indicators on research, innovation and competence may not capture the reality of the innovation systems. . To find ways to define the embryonic elements of the innovation process is therefore a challenge and to develop alternative indicators that capture these elements is a major challenge and probably this needs to be done through testing different concepts and ideas in empirical work.<sup>74</sup>

The author is in agreement with Lundvall's premise. The diffusion, adaptation and use of new technology are what are being studied using Kim's technology trajectory framework for South Korea. In that respect innovative activities are taking place in sub-Saharan Africa, albeit at a slow pace. However the author does agree with the analysis.

#### **2.4 Science and Technology Indicators**

The collection of science and technology indicators was standardised in 1963 by the OECD when they met with national experts on research and development (R&D) statistics in Frascati, Italy. The result was the first official version of the Proposed Standard Practice for Surveys of Research and Development, better known as the Frascati Manual.<sup>75</sup> The document has been revised six times and is currently in the sixth edition. It has become the standard used worldwide for the collection of science and technology indicators.

The Frascati Manual is not only a standard for R&D surveys in OECD member countries. As a result of initiatives by the OECD, UNESCO, the European Union and various regional organisations, it has become a standard for R&D surveys worldwide.<sup>76</sup>

The Frascati Manual was developed by members of the OECD community, who come from developed countries, where the collection of R&D indicators as listed in the manual is done systematically. In developing nations however, collecting research and development indicators as indicated in the manual has proved a challenge due, to among many other reasons the scarcity of resources (both monetary and human) to undertake the exercise. These

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<sup>74</sup> Lundvall BA. 2007. National Innovation Systems – Analytical Concept and Developmental Tool. *Industry and Innovation*. 14(1): 95-119.

<sup>75</sup> OECD. 2002 *Main Science and Technology Indicators*. Paris

<sup>76</sup> OECD. 2002 *Main Science and Technology Indicators*. Paris

problems are common to many developing countries as Gaillard<sup>77</sup> points out. Gaillard lists the following implications for the Frascati Manual:

1. The first implication is related to the paucity of reliable, up-to-date statistical information on human resources and research budgets in many of the developing countries, particularly in Sub-Saharan Africa and the Arab countries.
2. The second implication is related to the high concentration of scientific activities in a small number of countries in each region.
3. The third implication is related to the professional crisis and the changing nature of scientific work in many countries, which makes it more complicated to assess R&D personnel data, particularly within the universities, where, in most countries, the bulk of R&D personnel is employed. Given the fluidity of a large number of contractual part-timers who teach in the universities, there is a high risk of counting them twice, or more. Given the fact that many staff members have a second job or a parallel, additional remunerated activity to compensate for the drop in their purchasing power, they may not devote much time to scientific research at all. This leads to further difficulties in estimating the number of staff truly involved in R&D activities and the time they spend on it.
4. The fourth implication is related to the difficulty of evaluating national R&D budgets accurately. An increasing number of private funding sources (notably, foundations and non-governmental organisations [NGOs]) provide support to individuals, groups or programmes and not to institutions. Tracing the amount and flow of these funds is not easy, since, in most cases, they are not declared. In addition, many institutions (in particular, universities) do not have an official, transparent research budget since research is a subordinate function to teaching, the main or even exclusive function. Finally, confusion between S&T and R&D expenditures often leads to overestimated or underestimated R&D budgets. All these characteristics make it difficult to construct an R&D national budget.
5. The fifth implication is related to the increasing international circulation of scientists and engineers, particularly from developing countries, and the proposal to organise

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<sup>77</sup> Gaillard J. 2010. Measuring Research and Development in Developing Countries Main Characteristics and Implications for the Frascati Manual. *Science Technology & Society*. 15(1): 77-111.

them into an S&T diaspora that, through ‘remote mobilisation’ all over the world, will generate a number of benefits for their home countries.

6. The sixth implication. R&D indicators alone cannot fully explain the characteristics of R&D in developing countries, for example, the dynamics of R&D systems, R&D practices, informal behaviours and contributions as well as unexpected changes, just to mention a few. It is, therefore, argued that to go beyond indicators, additional surveys should be conducted to produce descriptors and narratives on additional issues.<sup>78</sup>

The following were suggested by Gaillard in order to overcome the above mentioned shortcomings in science and technology indicators.

- The use of descriptors such as: number and date of establishment of first public and private research institutes, public and private universities, professional associations, ministries of science, science policies.
- Narratives of the strengths and weaknesses of the national research system, the role of government, other national agencies and international institutions in funding research (public and private), the impact on the national research agenda and priorities on funding received, the profession and status of academics and knowledge workers, scientific mobility and brain drain challenges etc.

Therefore Gaillard argues that there is a need to go beyond indicators, additional surveys should be conducted to produce descriptors and narratives (highlighted above) on subjects that include:

1. The contextualisation of the science system within the broader political, economic, educational and social systems.
2. The history of science in the country.
3. The governance of science in the country and available policy documents.
4. Knowledge and R&D performers.
5. Informal S&T structures (academies, associations, trade unions, journals, and so on).

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<sup>78</sup> All six implications obtained from Gaillard J. 2010. Measuring Research and Development in Developing Countries Main Characteristics and Implications for the Frascati Manual. *Science Technology & Society*. 15(1): 77-111.

6. Research outputs (postgraduates, publications, papers and patents).
7. Scientific cooperation and agreements both national and international.

The aim therefore for developing countries is to develop an effective science and technology system and structure that is able to lobby and draw finances from the central government in order to finance its activities, and to implement science and technology strategies that target priority sectors of the economy.<sup>79</sup> These ideas from Gaillard informs the method used in presenting the material for this thesis in the following chapters.

## 2.5 Applicability

This thesis will explore three sectors namely, agriculture, industry and science and technology from 1964 to 2012 in order to examine government strategies within the sectors. Each national innovation system will be described and policies or strategies developed within the era will be investigated, in order to determine if the country is moving from exporting raw materials to value addition. In addition the exports in each sector will be examined to establish whether the sector added value to exported goods.

The science policy constitutes many fields e.g. health, industry, agriculture, mines, defence, water, environment and natural resources. The dissertation narrows the fields of study to the policies formulated for the agricultural and industrial sectors only, to find out if Zambia is moving from exporting raw materials to value addition and technology development during the period being studied. Figure 8 below illustrates the dynamic perspective that will be used to analyse the two sectors.

The study examines two phases of National Innovation Systems of Zambia from 1964 to 1996 and the second from 1997 to 2012. This has been split into two because of the two different structural frameworks that have governed the science sector. As figure 8 shows the study will be broken into ten year sections for easy analysis, with the policies that were used at the time covering the bottom half of the graph. The top graph will show the agricultural commodities exported and the volume through the years.

In the market mechanism perspective the different goods produced by the country through the years will be investigated. Analysis of the policies in the three different sectors, namely

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<sup>79</sup> Gaillard J. 2010. Measuring Research and Development in Developing Countries Main Characteristics and Implications for the Frascati Manual. *Science Technology & Society*. 15(1): 77-111.

agriculture, industry<sup>80</sup> and science and technology will be done by examining the goods produced and exported through the years. Answers to three questions will be sought

1. Did the policies create market needs for technologies?
2. Did the policies increase the science and technology capabilities of the country?
3. Were effective linkages created between the demand and supply side?

The technology flow perspective will examine whether the country assimilated foreign technologies. That is, where industries developed that added value to raw materials? Was the country moving from exporting raw materials to value addition?

The aim of this thesis is to see whether Zambia is moving towards value addition using the existing innovation system as compared to the previous one. The study could also inform the future science and technology policy. Kim's technology trajectory could provide the country with a way of analysing its science policies and whether they contribute to the desired trajectory.

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<sup>80</sup> Industry studied excludes the mines.

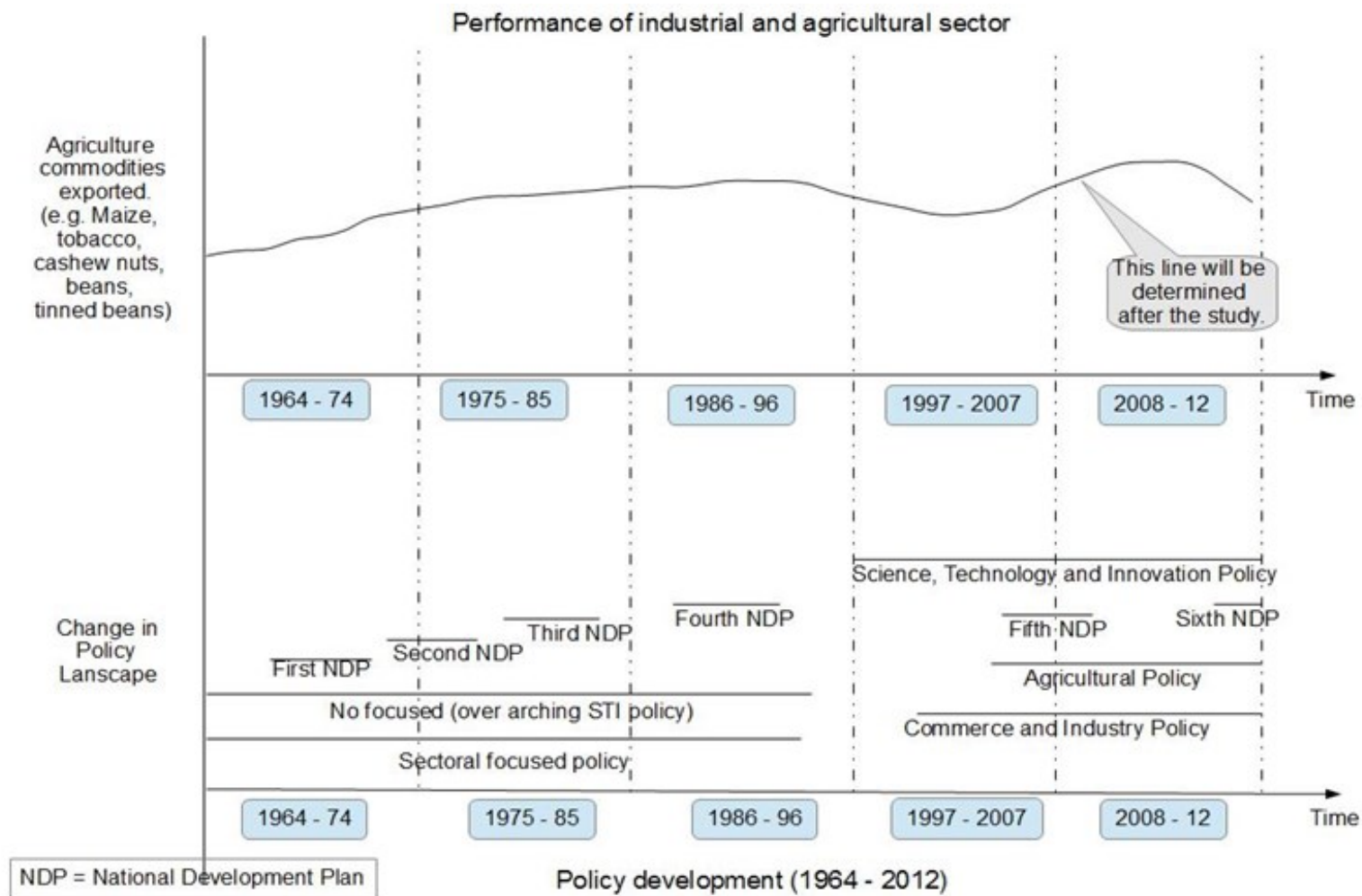


Figure 8: Adapted dynamic perspective from Kim's model.



# Chapter Three

## Zambian National Innovation System 1964-1996

### 3.1 Narrative Zambian NIS from 1964 to 1996

In 1967 the Zambian government established the National Council for Scientific Research (NCSR) through an act of parliament (Act No. 55 of 1967). The model was developed by the United Nations Educational, Scientific, and Cultural Organisation (UNESCO) to help developing countries manage scientific research and innovation.<sup>81</sup>

The NCSR fell under the Office of National Development and Planning, which developed the National Development Plans for all sectors of the economy for the whole country. The Council was tasked with, among other things;

1. Co-ordinating the science sector in Zambia and influencing research priorities in the development plans so as to achieve economic development.
2. Disbursing research and development funds from government. Research institutions applied to the NCSR for research grants.
3. Carrying out research.<sup>82</sup>

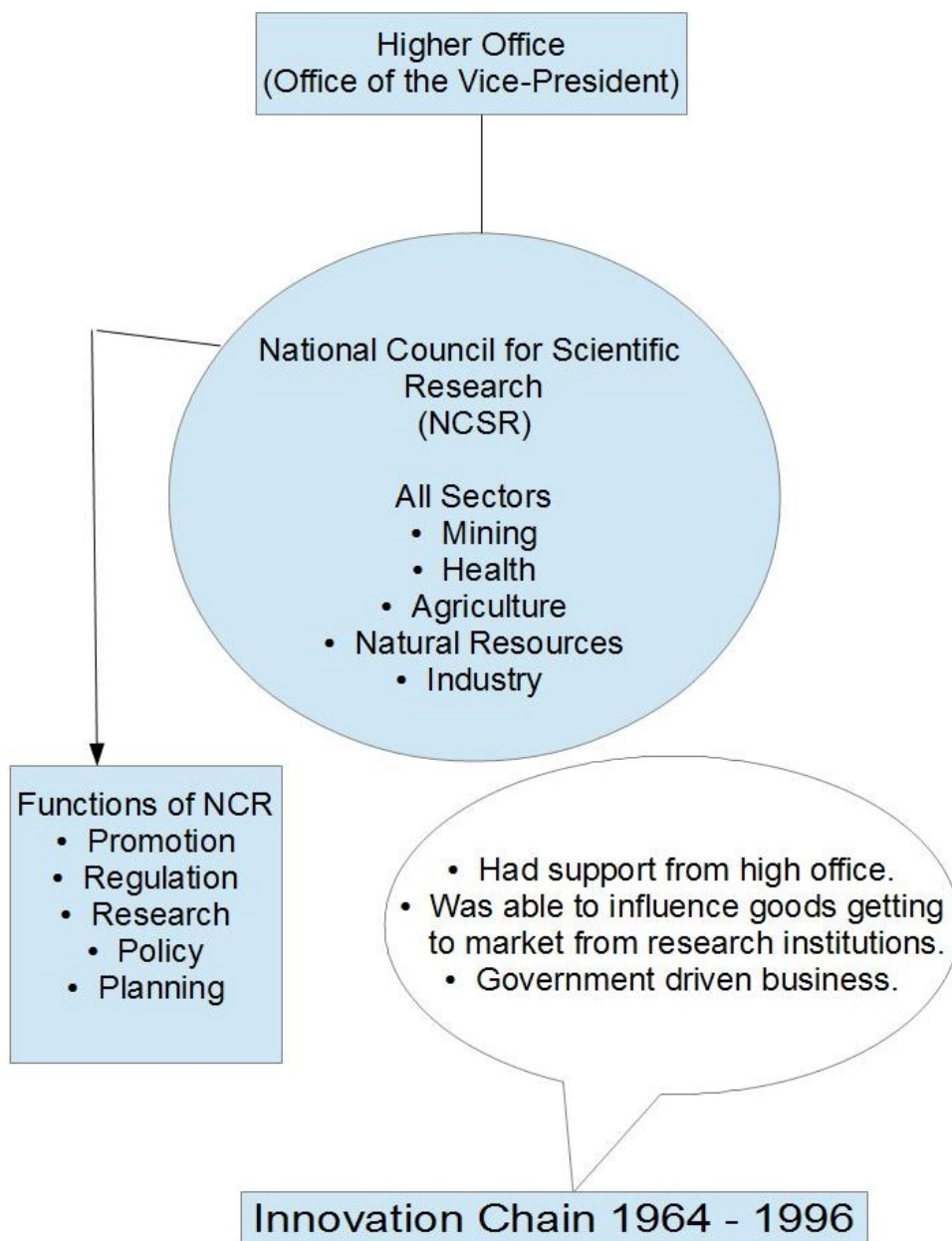
The first national development plan concentrated on agriculture as a means of diversifying the economy and creating employment. Therefore three applied research areas were targeted namely veterinary research, soils and crop research and fisheries research. In this respect the following institutions were targeted:

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<sup>81</sup> Vitta PB. 1990. Technology policy in sub-Saharan Africa: Why the dream remains unfulfilled. *World Development* 18(11): 1471-1480.

<sup>82</sup> All three points obtained from National Council for Scientific Research. 1967. Annual Report for National Council for Scientific Research

1. The Research Branch of the Department of Agriculture established in 1952 became the Zambia Agriculture Research Institute for all crop related research (including



**Figure 9: National Innovation System 1964 - 1996**

soils). Satellite centres were established in all nine provincial capitals, each specialising in crops commonly grown in the areas.<sup>83</sup> The stations' main objective was to cater for the agriculture needs of farmers in the respective provinces. For

<sup>83</sup> From Office of National Development and Planning. 1966. *First National Development Plan*. Government of Zambia. Lusaka, Zambia

example cassava the main food crop of the people in Luapula Province and groundnuts which is the main food crop of the people in Eastern Province.

2. The Central Research Station established in 1927 became the Central Veterinary Research Institute tasked with the research of veterinary diseases that affect livestock through out the country. The centre is based in Lusaka the capital city.<sup>84</sup>
3. The Central Fisheries Research Institute – The Fisheries Research Division established in 1962. It was tasked with handling all fisheries related research. Fisheries research stations were set up at four lakes found in the country, namely Lake Bangweulu, Lake Tanganyika, Lake Mweru and Lake Kariba.<sup>85</sup>

The University of Zambia (UNZA) and the Zambia Institute of Technology (now the Copperbelt University) were also set up during this time. The University of Zambia was built at a total cost of K2,988.00<sup>86</sup> (in millions of Kwacha) over a period of three years beginning 1967. The institution was allocated on average 0.5% of the national budget during the construction phase. However construction continued even after the university admitted its first students.<sup>87</sup> The Zambia Institute of Technology was established in 1987 at a cost of K36,584.00<sup>88</sup> (in millions of Kwacha). The allocation amounted to 0.2% of the national budget on average for each of the two years that the institution was under construction.

This NIS operated in a command driven economy that was government controlled through out the whole value chain from farms to shops, including the industries. In addition, price controls were also in effect.

### 3.2 Policy: First National Development Plan

During the period 1964 to 1996 the country had four National Development Planning documents that spelt out the strategies for the country. The First National Development Plan (FNDP) acknowledged the fact that Zambia was highly dependent on copper as its main source of revenue and that copper greatly determined the level of economic activity in the

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<sup>84</sup> From Office of National Development and Planning. 1966. *First National Development Plan*. Government of Zambia. Lusaka, Zambia

<sup>85</sup> From Office of National Development and Planning. 1966. *First National Development Plan*. Government of Zambia. Lusaka, Zambia

<sup>86</sup> Figures obtained from the Government of the Republic of Zambia. April 1967 to March 1969. *Estimates of Revenue and Expenditure*. Inflation not accounted for.

<sup>87</sup> From Office of National Development and Planning. 1966. *First National Development Plan*. Government of Zambia. Lusaka, Zambia

<sup>88</sup> Figures obtained from the Government of the Republic of Zambia. April 1988 to March 1989. *Estimates of Revenue and Expenditure*. Inflation not accounted for.

country. Therefore it aimed to diversify the economy by investing in the agriculture and manufacturing sector.<sup>89</sup> The FNDP that ran from 1966 to 1970 and had little to no mention of science and scientific research. The National Council for Scientific Research only began its operations in 1967. It was tasked with advising government on science and technology, conducting research, funding research in other institutions and promoting science. It also implemented government policy in regards to science and technology.

The dual structure of the economy was more pronounced in the agriculture sector, with a few farmers producing on a commercial scale while most were subsistence farmers struggling to grow enough for their own consumption. In addition rural urban migration was a big concern of the government. In order to halt rural urban migration the government planned to develop small rural enterprises. For example a project to teach semi-processing of hides in the rural areas. The government also planned to establish ranches and production schemes across the country.<sup>90</sup> Research in the agriculture sector included the expansion of central and regional research stations and the production of improved crop varieties. The government committed to only investing in applied research and not basic research.

The policy for the industrial sector was twofold firstly to create industries which would substitute locally produced products for many imported ones and secondly to create centres of economic activity away from the line of rail in order to transform the stagnant rural sectors.<sup>91</sup> Under the Federation Northern Rhodesia (Zambia) and Nyasaland (Malawi) supplied the raw materials while the role of secondary industries was left to Southern Rhodesia (Zimbabwe). The policy of import substitution was to be used. It was anticipated that in the later years industries would develop exports to neighbouring countries that were of international quality. However the FNDP was considered as the preliminary phase of the industrialization programme consuming massive capital funds with little economic benefit.

The role of the government was to provide encouragement and assistance to the private sector and in certain cases to establish new industries. The projects undertaken included (among others) the industrial programme in which government built and managed the industries, and the loan capital programme in which loans were given to entrepreneurs.

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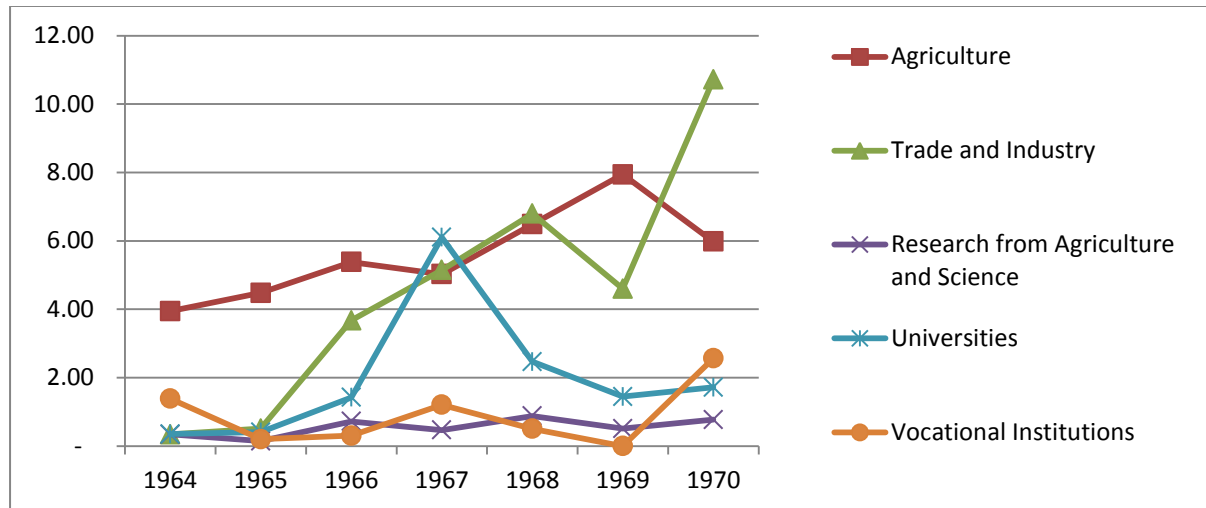
<sup>89</sup> From Office of National Development and Planning. 1966. *First National Development Plan*. Government of Zambia. Lusaka, Zambia

<sup>90</sup> From Office of National Development and Planning. 1966. *First National Development Plan*. Government of Zambia. Lusaka, Zambia

<sup>91</sup> From Office of National Development and Planning. 1966. *First National Development Plan*. Government of Zambia. Lusaka, Zambia

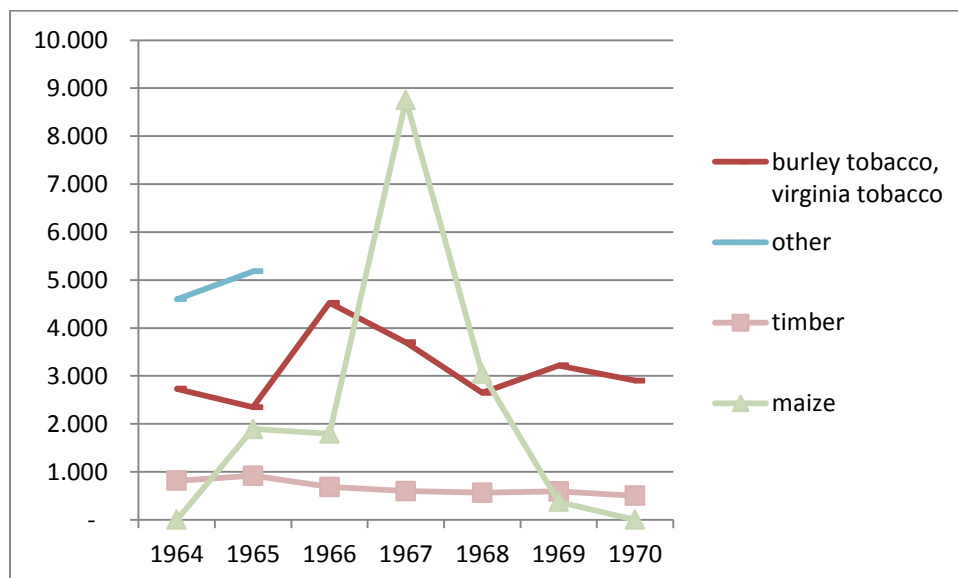
### 3.2.1 Budget, Expenditure and Top Export Products

The FNDP focused mainly on capital expenditure. The graph below highlights the expenditure of the country in the sectors being studied during the plan. During the period under review the country spent on average 48% of the budget on capital expenditure. However a great deal of the budgeted expenditure was spent on education which included the building of schools, colleges and universities. This was to improve the pool of skilled labour in the country, as it was a scarce resource at the time.



**Figure 10: Proposed Expenditure for 1964 to 1970**

Exports during the period consisted mainly of raw materials with little to no value addition. The graph below shows the exports in the agricultural sector during the period.



**Figure 11: Exported products in the agriculture sector during the period (in K 'millions)**

### 3.2.2 Contribution to GDP Comparison and Patents

The country saw important gains during the short period. The gross domestic product rose and agriculture contributed on average 11% towards it. A number of new industries were set up in the manufacturing sector, with the sector achieving a growth rate of 9% by 1969. In addition the country spent on a public investment programme. However the agriculture sector performed poorly during the period the actual growth rate was only 3.3%.

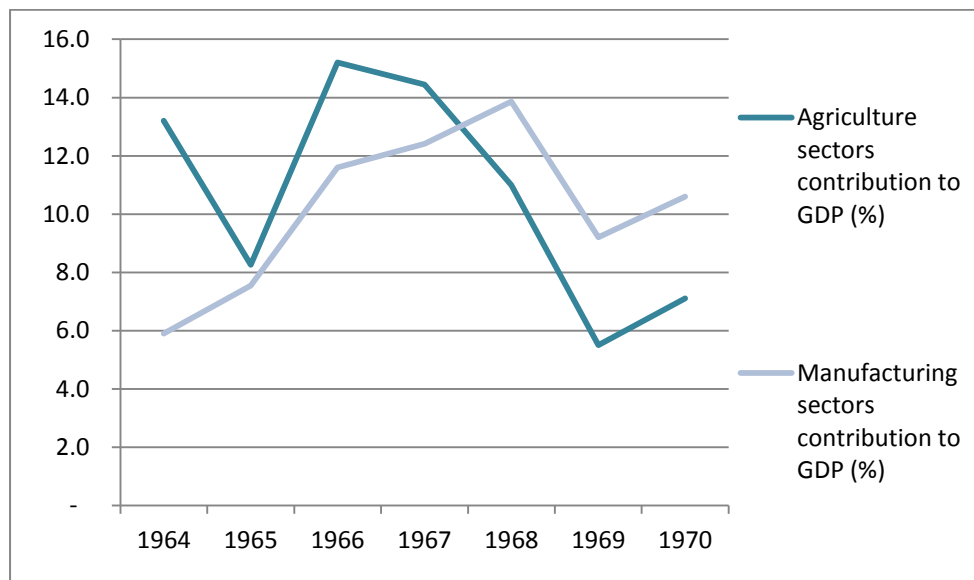


Figure 12: Manufacturing and agriculture sectors contribution to GDP from 1964 to 1970.

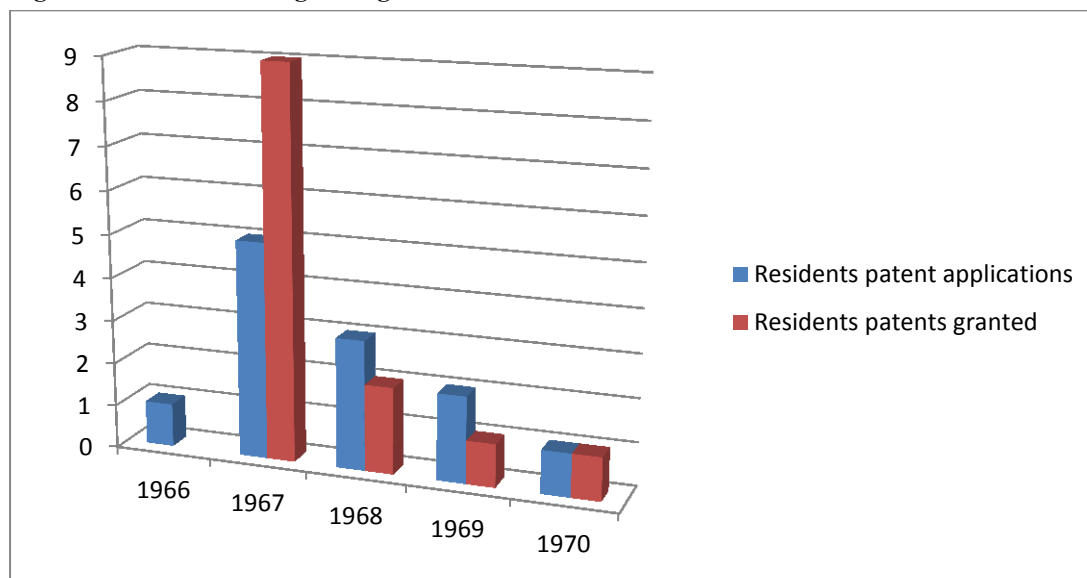


Figure 13: Patent data for residents from 1966. Source: WIPO Statistics Database.

### 3.3 Policy: Second National Development Plan

The Second National Development Plan (SNDP), which ran from 1972 to 1976, sought to continue on the efforts of the first plan by building the country's economic and social

infrastructure. The plan would also concentrate on the agriculture and manufacturing sector. The main strategies that the SNDP would follow included:

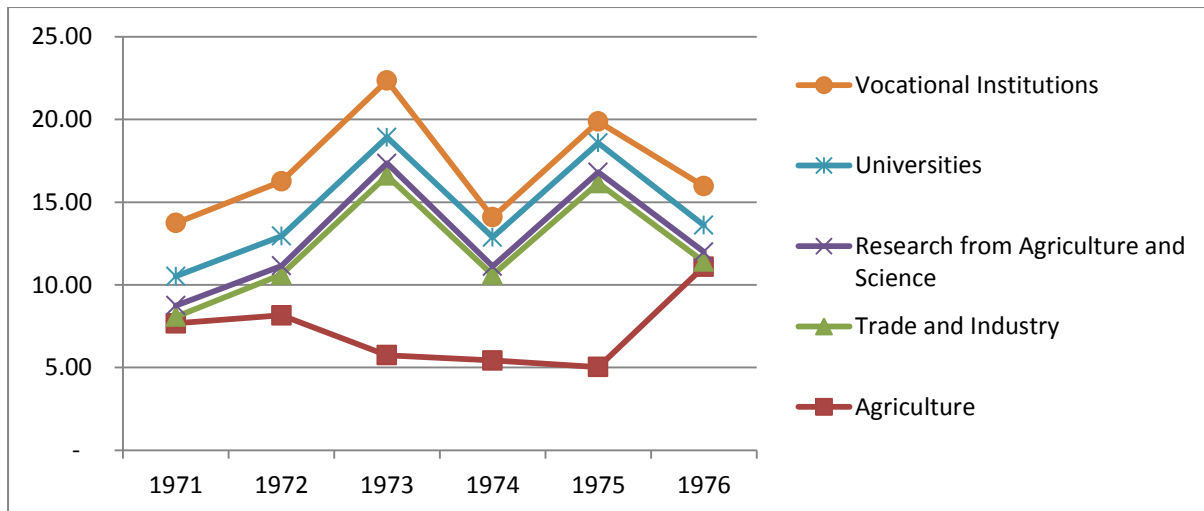
1. The expansion of agricultural production with the aim of improving the income and nutritional standards of the population.
2. To increase the contribution of the manufacturing and agricultural sectors towards GDP.
3. Expansion and diversification of the manufacturing sector.

The government's intention during the period of the plan was to control prices, increase the production of tobacco, protein and protective foods, and development of the livestock industry. The SNDP aimed to concentrate scarce resources, especially capital and manpower, towards the development of the rural areas by the development of Intensive Development Zones. This was in order to reduce migration to urban areas. The government still pursued a policy of import substitution especially of food products. In addition the plan aimed to increase the processing of raw materials originating from the agriculture sector.

In the SNDP the research focus was in the agricultural sector on crops, forestry, animal productivity, food, tsetse fly control, fisheries and wildlife. Research stations were set up where none existed with the aim of building research stations in every regional centre in the country. In the manufacturing sector the government pursued a policy of industry led research. That is industries sought assistance from the National Council for Scientific Research if there were any products they wished to develop.

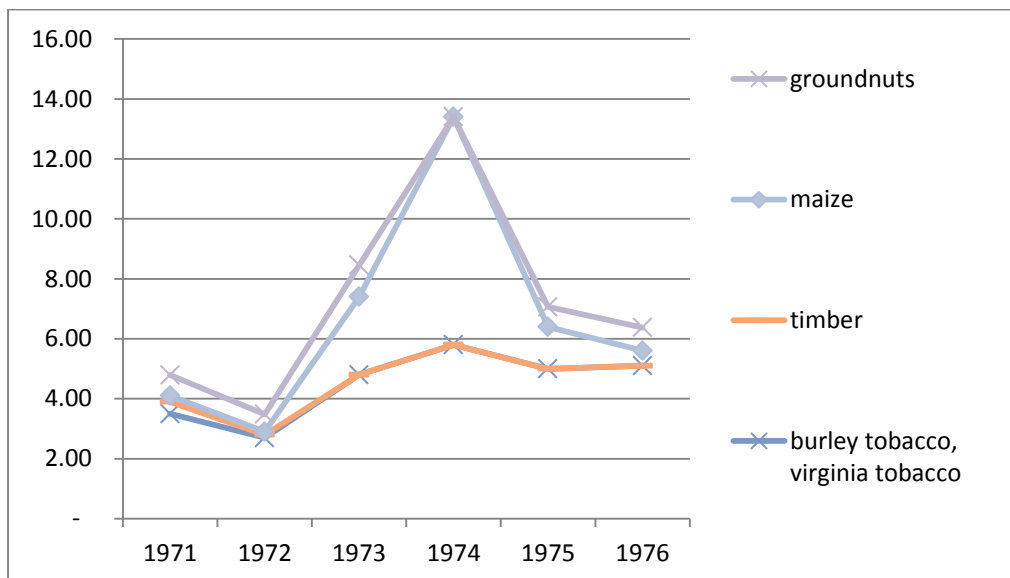
### **3.3.1 Budget, Expenditure and Top Export Products**

The National Council for Scientific Research was fully operational in the SNDP. This is highlighted by the increase in expenditure towards research. In addition the plan aimed at increasing the number of industries created, hence the increase in the expenditure towards the ministry of commerce and industry.



**Figure 14: Proposed Expenditure for 1971 to 1976**

A big constraint faced in the country was a need for skilled and trained manpower to undertake the activities under the plan. Therefore, the period under study saw a marked increase in the amount spent towards vocational institutions; in addition several trade schools were set up, one in every province.



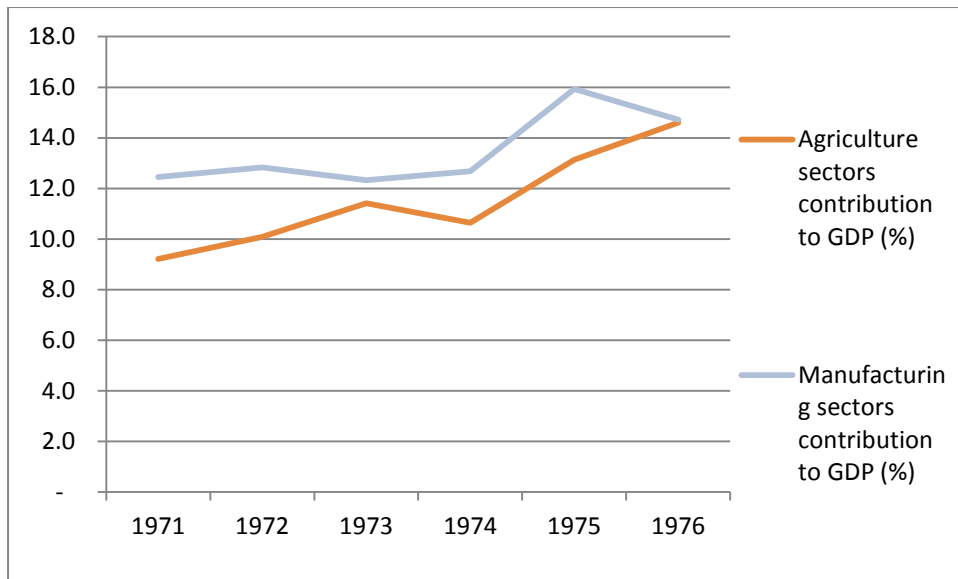
**Figure 15: Exported products in the agriculture sector during the period (in K 'millions)**

The country's main agricultural exports were products with little to no value addition.

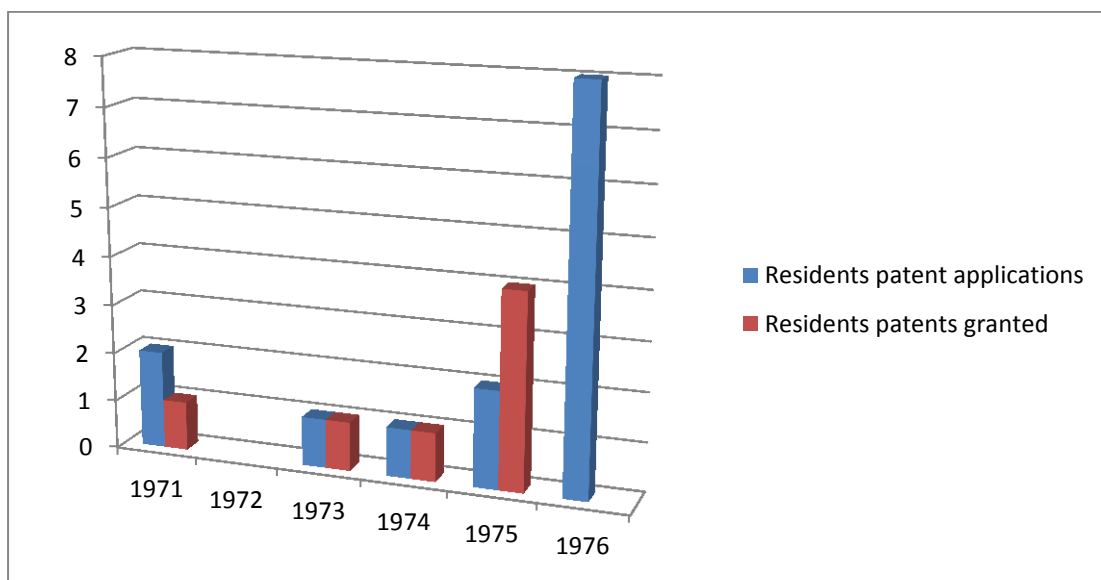
### 3.3.2 Contribution to GDP Comparison and Patents

With increased expenditure towards research, and education little to no change was noted in the indicators under the study, especially to goods exported. The country still exported raw materials; however there was an increase in the sectors contribution to GDP as highlighted in the graph below.





**Figure 16: Manufacturing and agriculture sectors contribution to GDP from 1971 to 1976.**



**Figure 17: Patent data for residents from 1971. Source: WIPO Statistics Database.**

### 3.4 Policy: Third National Development Plan

The Third National Development Plan (TNDP) was from 1979 to 1983 and it would focus on diversifying the economy. The government's policy in the manufacturing sector was to encourage the use of locally produced raw materials for the industries that would be set up or the ones that were currently running. Attention would be paid to the development of groups of inter-dependent industries able to supply each other. The plan would focus on agro industries such as milling, cooking oil and margarine production, sugar production, stock feed and forest based industries. In addition the policy entailed that the government either

owned industries or was a major shareholder, was in operation at the time. Furthermore the policy of import substitution was still being used.

In the agriculture sector the TNDP called for an increase in agriculture exports, the country should be self-reliant in terms of the staple diet (maize), and an increase to the standard of living of people in the rural areas to counteract rural urban migration. This would be done via price controls, a more efficient means of collecting agriculture products from outlying areas of the country and improved storage mechanisms, provision of better training facilities and the expansion and improvement of existing research facilities.

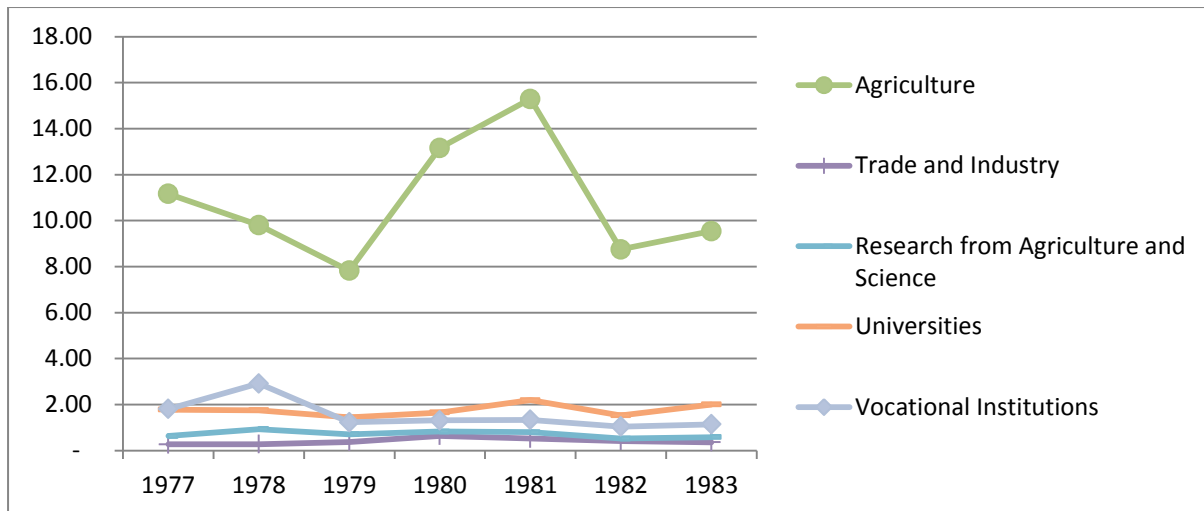
Research activities for the period would focus on maximizing the potential of the different ecological zones in the country. The regional research stations would concentrate on local problems and, production of crop varieties for commercial farmers. In addition the plan aimed to establish a livestock research division and station. The NCSR in the industrial sector would develop and aim to demonstrate that local raw food materials (both cultivated and wild) could be used to produce high quality processed foods.

#### **3.4.1 Budget, Expenditure and Top Export Products**

The TNDP aimed to diversify the economy and one of the strategies involved the use of the agriculture sector, “to undertake a crash economic programme of promoting agriculture and industry based on [the] use of local raw materials and the establishment of the necessary capital goods industries.”<sup>92</sup> The plan aimed to invest heavily in the rural sector by empowering the subsistence farmers. The expenditure in the TNDP illustrates this (figure 18).

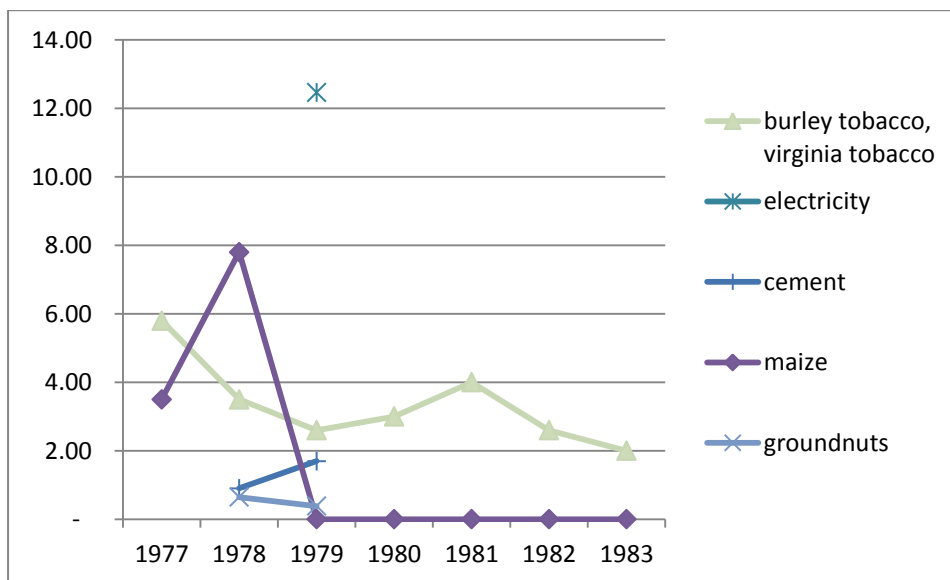
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<sup>92</sup> Office of President National Commission for Development Planning. 1979. *Third National Development Plan 1979 – 1983*. Lusaka



**Figure 18: Proposed Expenditure for 1977 to 1983**

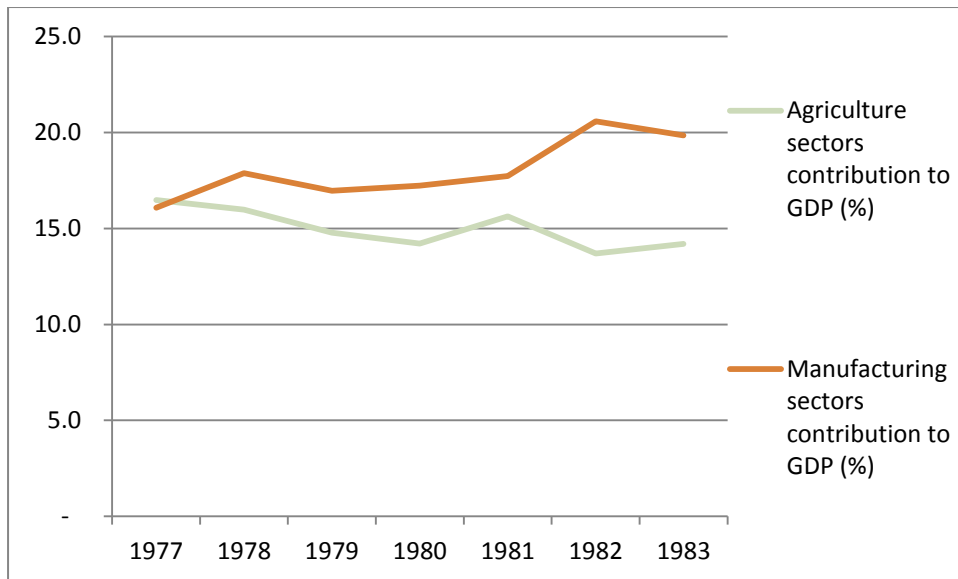
Figure 19 shows the goods exported during the period. However nothing was noted in the agro-processing, and food technology industries, this could be due to the time it takes to set them up.



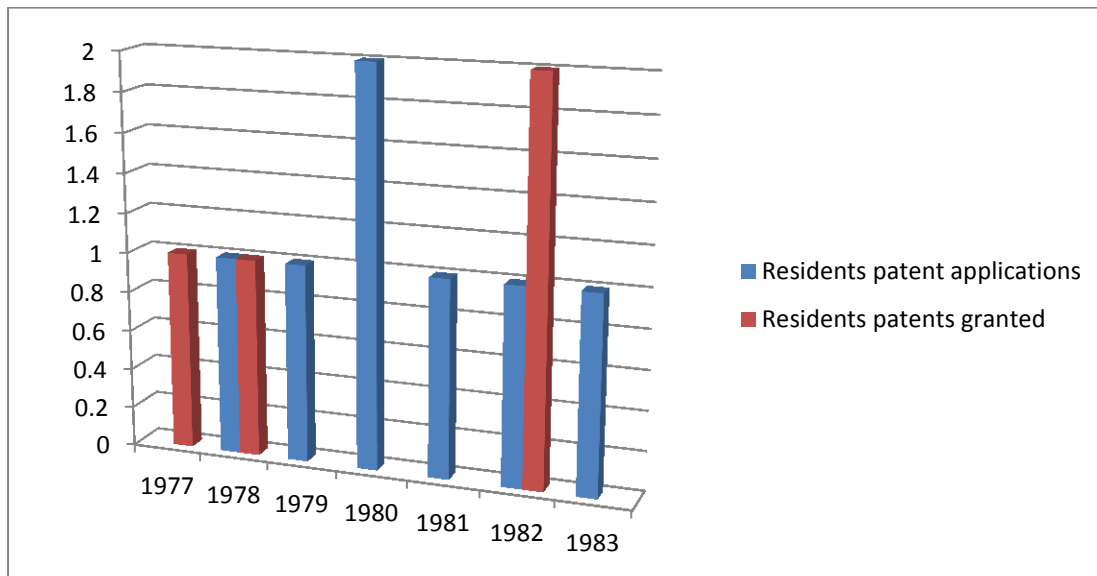
**Figure 19: Exported products in the agriculture sector during the period (in K ‘millions)**

### 3.4.2 Contribution to GDP Comparison and Patents

Goods exported during the period show a marked decrease. Even the traditional agricultural exports did not do well; however, the agriculture and manufacturing sector’s contribution to GDP saw a positive trend.



**Figure 20: Manufacturing and agriculture sectors contribution to GDP from 1977 to 1983.**



**Figure 21: Patent data for residents from 1977. Source: WIPO Statistics Database.**

### 3.5 Policy: Fourth National Development Plan

During the Third National Development Plan (TNDP) the price of base metals in the world market fell, and the subsequent government deficit meant it was difficult to achieve the planned activities. This situation was carried through to the Fourth National Development Plan (FNDP, 1987- 1991), with an external debt to service and the depreciation of the kwacha by 425%<sup>93</sup>. The overall national budget deficit widened. In FNDP, the aim was to stimulate economic recovery and promote sector wide long term growth by reducing the dependence of the country on imports and to strengthen domestic demand.

<sup>93</sup> Government of the Republic of Zambia. 1987. Estimates of Revenue and Expenditure

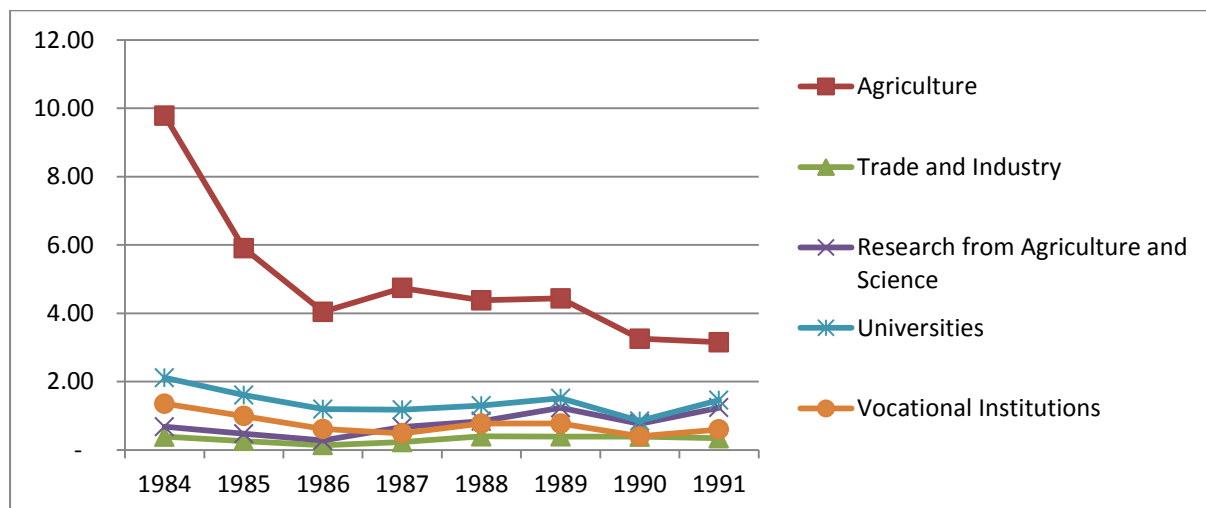
The agriculture sector was key to the FNDP because it employed about 51% of the workforce. The plan called for an increase to strategic crops to reduce the raw materials agro-industries had to import, to increase the export of agriculture products, to achieve self-sufficiency in the production of the country's staple foods and to improve rural incomes.

The manufacturing sector would be reorganised to supply all the major inputs to the agriculture sector and to process all produce from the farmers. Special attention would be paid to small scale industries.

Research in the TNDP was hampered by poor dissemination of information on research outputs, therefore in the subsequent plan this was put as priority. In addition, in the FNDP the research efforts would focus on making research more relevant to Zambia's development needs, especially in the fields of agriculture and manufacturing. The NCSR was also tasked with improving the coordination of research in the country. To this end all research activities which had hitherto been planned under each sector now fell under the Council. It planned for all research activities in all the sectors.

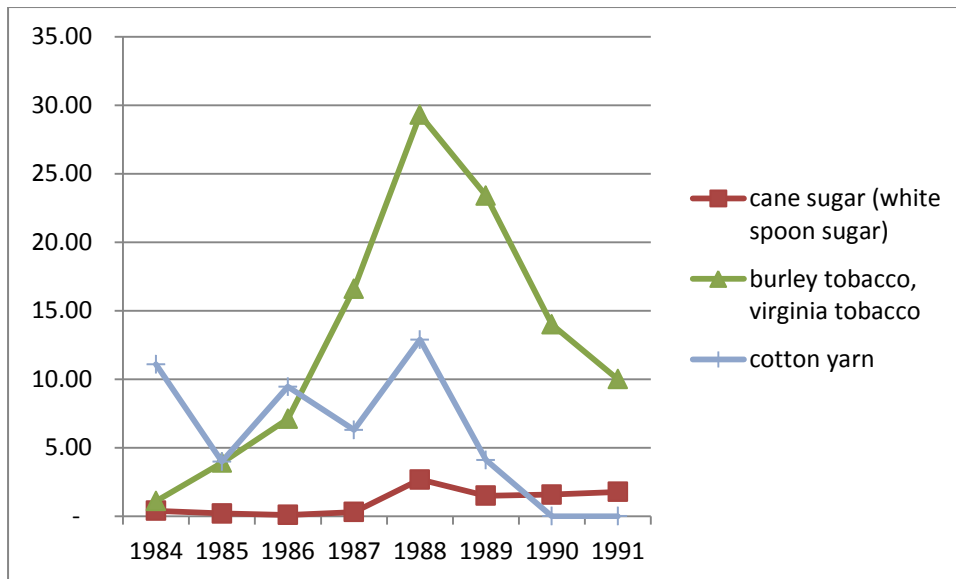
### 3.5.1 Budget, Expenditure and Top Export Products

The tough conditions that existed in the FNDP coupled with the depreciation of the kwacha all but eroded the gains of the plan. A reduced percentage of the expenditure went to services and sector spending as can be seen from figure 22 below.



**Figure 22: Proposed Expenditure for 1984 to 1991**

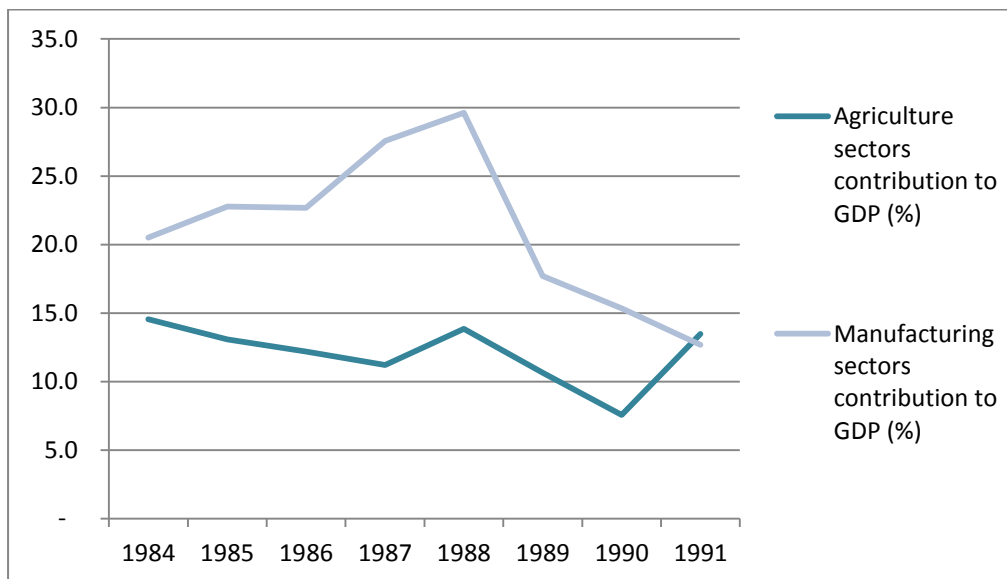
Figure 23 shows the goods exported during the period. Due to the difficulties faced, even traditional agriculture exports were in decline.



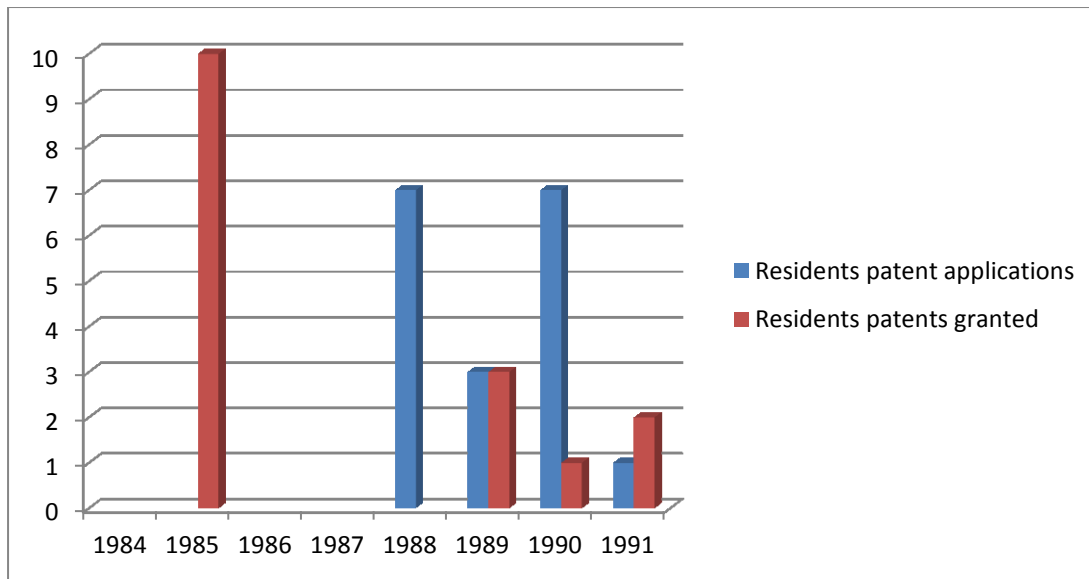
**Figure 23: Exported products in the agriculture sector during the period (in K 'millions)**

### 3.5.2 Contribution to GDP Comparison and Patents

A sharp decline was observed in the sector's contribution to GDP.



**Figure 24: Manufacturing and agriculture sectors contribution to GDP from 1984 to 1991.**



**Figure 25: Patent data for residents from 1984. Source: WIPO Statistics Database.**

### 3.6 Conclusion

During the first national development plan, the National Council for Scientific Research had just been established therefore not much was mentioned in the way of industrial research. However, at the time of independence the research branch of the Department of Agriculture, the Central Research Station and the Central Fisheries Research Institute (established in 1952, 1927 and 1962 respectively) existed, and research plans were included in the agriculture section of the first national development plan.

In the second, third and fourth national development plans, the National Council for Scientific Research planned for the research activities for all research institutions. All research stations sent their research plans to the Council. Funding was received by the Council for research and that was disbursed to government research centres across the country for scientific research in both agriculture and industrial sector.

The government had a central body that planned and coordinated the development needs of the country called the National Commission for Development Planning (NCDP), which fell under the Office of the President. The NCSR fell under the NCDP.

The national research system in this era was able to set up research stations, and co-ordinate research in the country on a country wide basis with all sectors taken into account. Using Linsu Kim's adapted model (figure 25) to compare the indicators it shows that the country during this period did not export many significant products that added value but the amount earned by the country (in US\$) for agriculture and manufacturing exports was increasing especially during the Fourth National Development Plan.

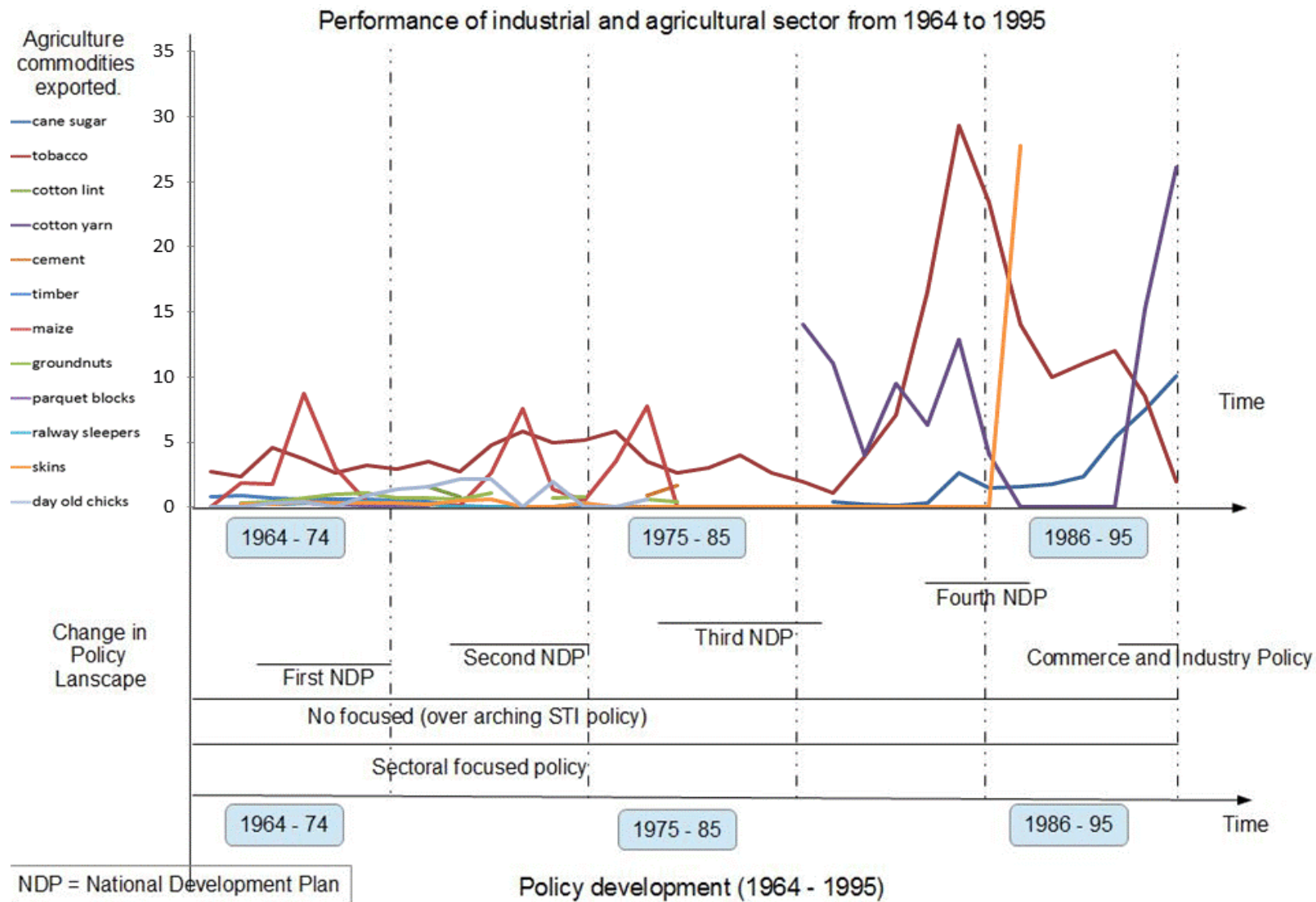


Figure 26: Linsu Kim's adapted model showing goods exported and the policy landscape.



# Chapter Four

## Zambian National Innovation System 1996-2012

### 4.1 Narrative Zambian NIS from 1996 to 2012

In 1991 the government system changed from mainly public owned industries and shops to privately owned industries. The government embarked on a major privatisation drive and many government owned enterprises were privatised. In addition price controls were lifted in favour of a more liberalised economy. With the change in the management of the economy the National Innovation System was revised by the implementation of the National Science Policy of 1996.

Though the NCSR was able to promote the science sector and carry out research very well, it was felt that it was not performing its advisory function well due to the weaknesses in its statutory linkages with other research institutions in the country.<sup>94</sup> There was a conflict of interest as the NCSR also carried out research. The policy proposed the establishment of three separate institutions with separate functions.

1. The National Science and Technology Council (NSTC) established by the Act of 1997. Its function was to regulate, fund, promote and coordinate the research in the science and technology sector. A specific fund was set up for the purpose called the Science and Technology Development Fund (STDF).<sup>95</sup>
2. The Act of 1997 also established National Technology Business Council (NTBC). The main function of NSTC was to co-ordinate, regulate and promote the science sector. The main objective of NTBC was to commercialise both proven national and

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<sup>94</sup> Ministry of Science, Technology and Vocational Training. 1996. *National Policy on Science and Technology*. Lusaka

<sup>95</sup> Ministry of Science, Technology and Vocational Training. 1996. *National Policy on Science and Technology*. Lusaka

international technologies for the benefit of entrepreneurs and business communities.<sup>96</sup>

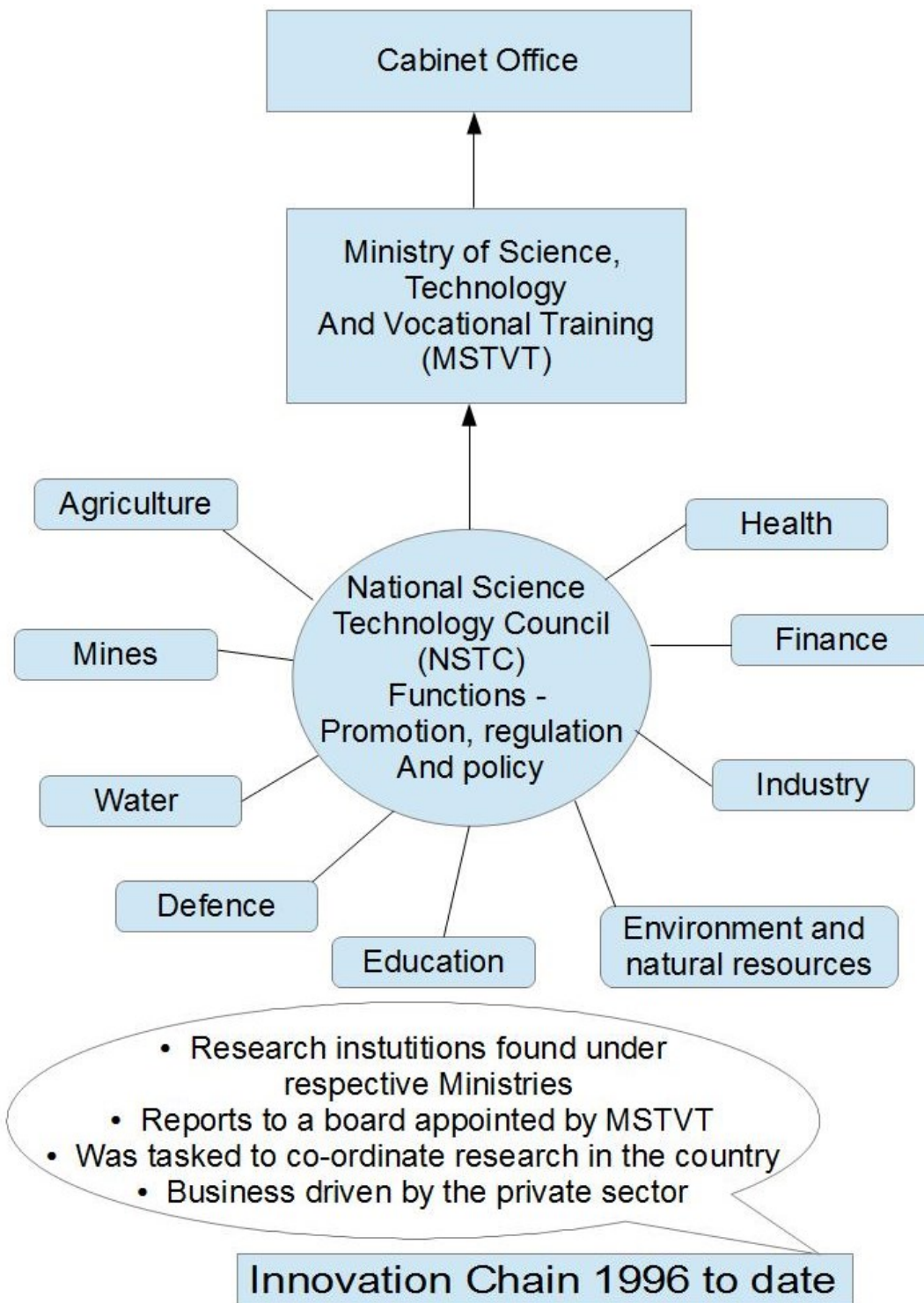


Figure 27 National Innovation System 1996-2012

<sup>96</sup> Ministry of Science, Technology and Vocational Training. 1996. *National Policy on Science and Technology*. Lusaka

3. In 2001 the Act that Established the NCSR was repealed and in its place was established the National Institute for Scientific and Industrial Research (NISIR) that took up the research mantle of the NCSR, including all assets and liabilities. All three institutions fell under the Ministry of Science, Technology and Vocational Training.<sup>97</sup>

The policy also enabled all research institutions to lobby central government directly for funds to carry out research. Therefore no funding requests came to any science and technology institution.

During this era only one government research institution was set up namely the National Remote Sensing Centre (NRSC) with an initial budgetary allocation of K62,135.00<sup>98</sup> (in millions of Kwacha) in 1999. This translated to 0.003 per cent of the national budget in 1999. However the amount was increased by the third year to K500,000.00<sup>99</sup> (in millions of Kwacha), which translated to 0.01% of the national budget. In addition many private organisations set up research centres. For example Centre for Infectious Diseases Research in Zambia (CIDRZ), Zambia Institute of Natural Medicine and Research (ZINMR), Alfred H. Knight and Mycorrliza Fungi Perfecti Limited.<sup>100</sup>

In 1991, the government moved towards sectoral policy documents as a means of strategically planning for the different sectors. Each sector produced a policy document that stipulated the strategies, objectives and implementation plans. However, in 2006, the government returned to development planning documents for the country with the aim of planning the development of the country as a whole. The objectives found in the sectoral policies fed into the fifth and sixth national development planning documents. The national planning documents, however determined the priority sectors for the government.

#### **4.2 Commercial, Trade and Industrial Policy**

Zambia's commerce and industrial policy was signed in 1994. It aimed to develop a competitive and export-led manufacturing sector in Zambia by targeting high priority sectors, providing appropriate incentives, and sustaining an appropriate enabling environment.<sup>101</sup> Six

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<sup>97</sup> Ministry of Science, Technology and Vocational Training. 1996. *National Policy on Science and Technology*. Lusaka

<sup>98</sup> Figures obtained from the Government of the Republic of Zambia, 1999. *Estimates of Revenue and Expenditure*. Inflation not accounted for.

<sup>99</sup> Figures obtained from the Government of the Republic of Zambia, 2001. *Estimates of Revenue and Expenditure*. Inflation not accounted for.

<sup>100</sup> National Science and Technology Council. 2009. *Registered Science and Technology Institutions*. Lusaka

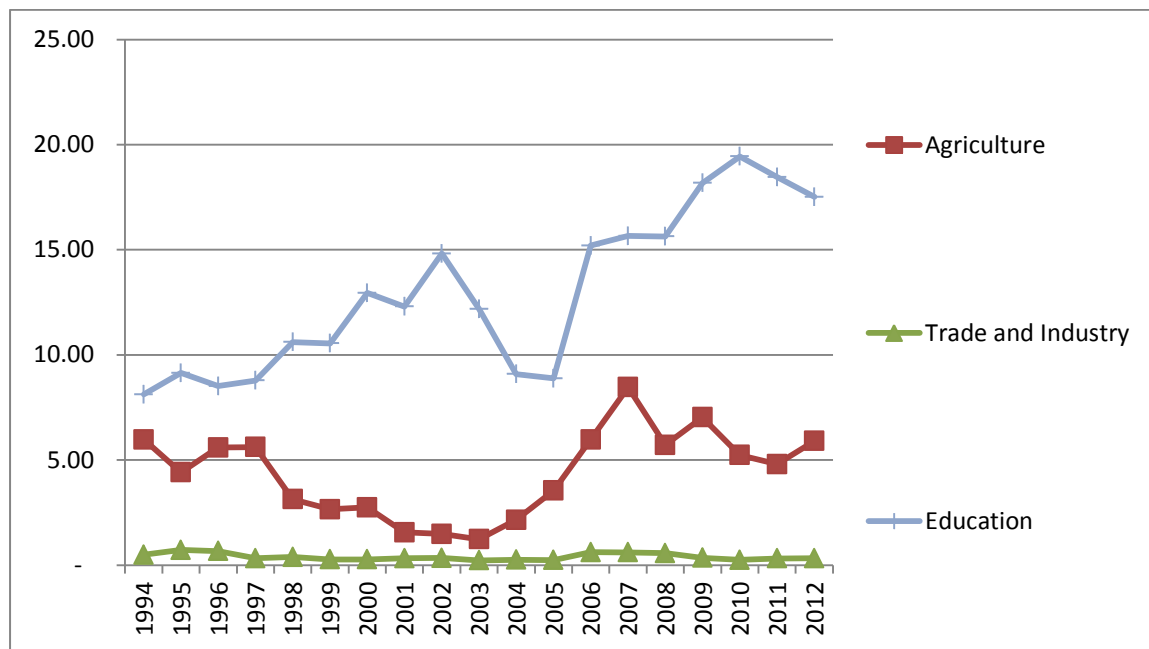
<sup>101</sup> Ministry of Commerce Trade and Industry. 1994. *Zambia commerce trade and industry policy*. Lusaka.

sectors were targeted namely processed foods, textiles and garments, engineering products, gemstones, leather and leather products and wood and wood products.

The trade policy aimed at encouraging the domestic trade sector, by supporting the activities of domestic firms and enhancing the growth of domestic trade. The goal was to assist domestic firms to increase their levels of efficiency, and withstand increasing competition from international firms that came to do business in the country.

#### 4.2.1 Budget, Expenditure and Top Export Products

The government allocation to trade and industry remained very low in comparison to other sectors. However the change from a command driven to market driven economy meant that government was not running business but providing an enabling environment for entrepreneurs.



**Figure 28: Proposed Expenditure for 1994 to 2012**

Figure 27 shows the goods exported during the period. The country was exporting sugar, cotton yarn, and mealie meal which are secondary industries to agriculture.

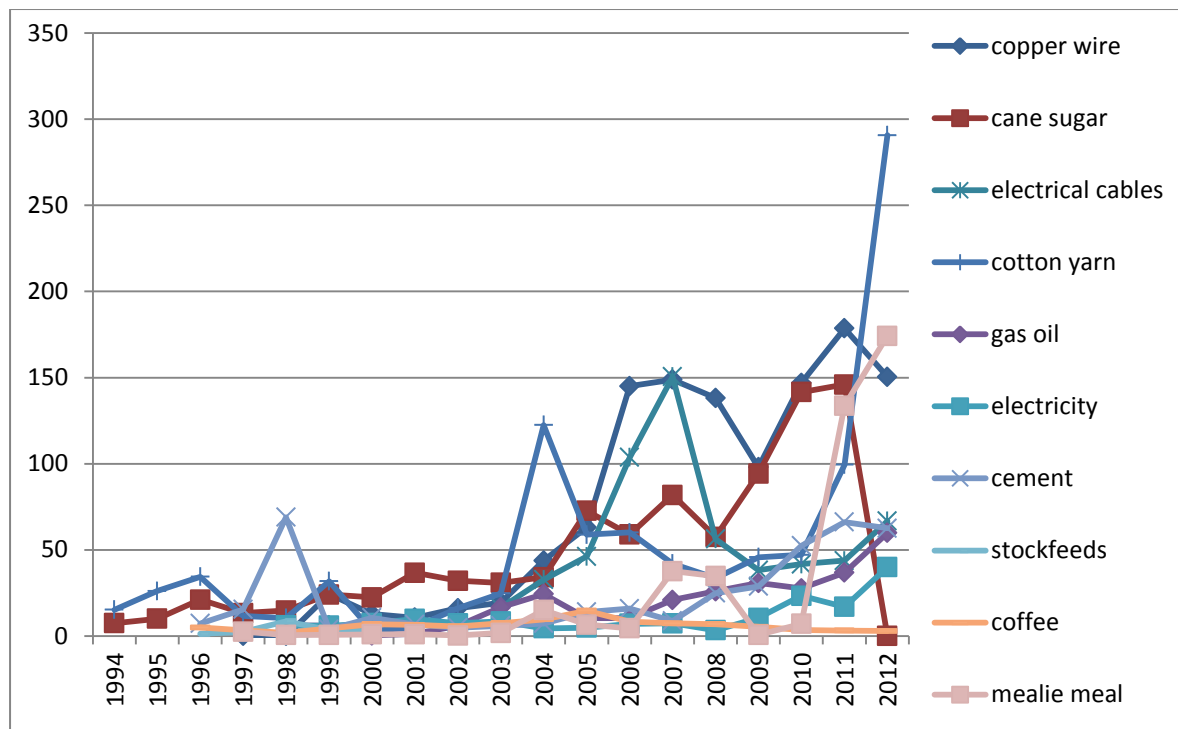


Figure 29: Exported products in the agriculture sector during the period (in K 'millions)

#### 4.2.2 Contribution to GDP Comparison and Patents

The agriculture sector contribution to GDP shows a steady rise while that of the manufacturing sector shows a slow but steady decline. This is besides the country exporting a lot of manufacturing products and the value noticeably rising through the years.

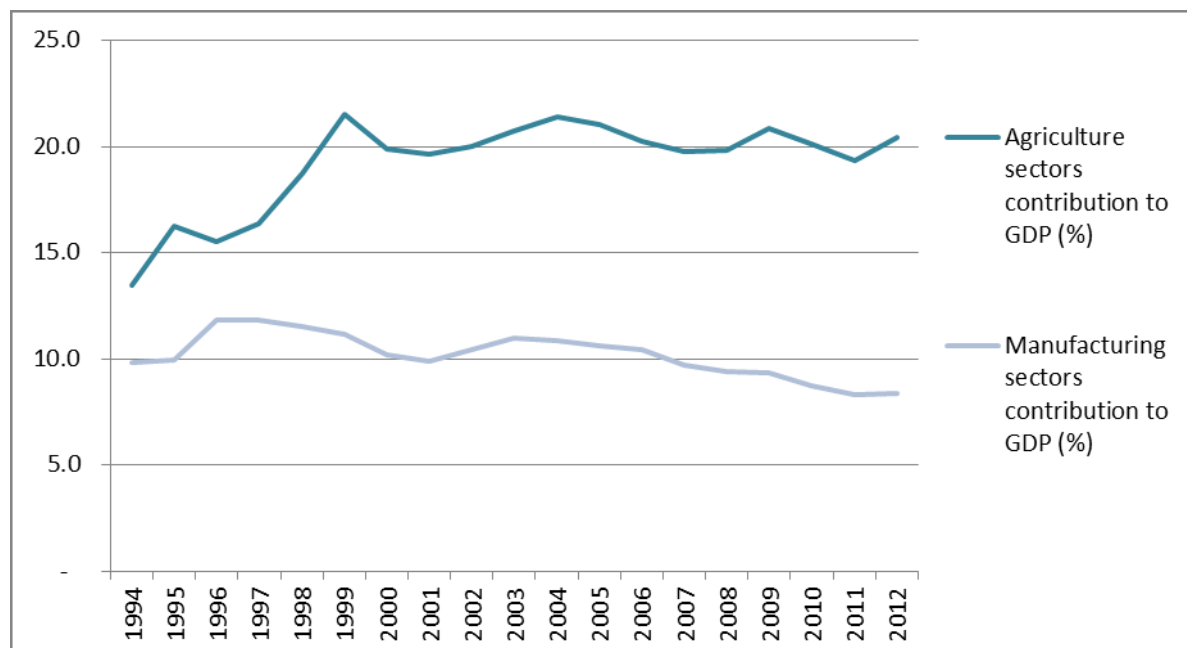


Figure 30: Sectors contribution to GDP and GDP growth through the years.

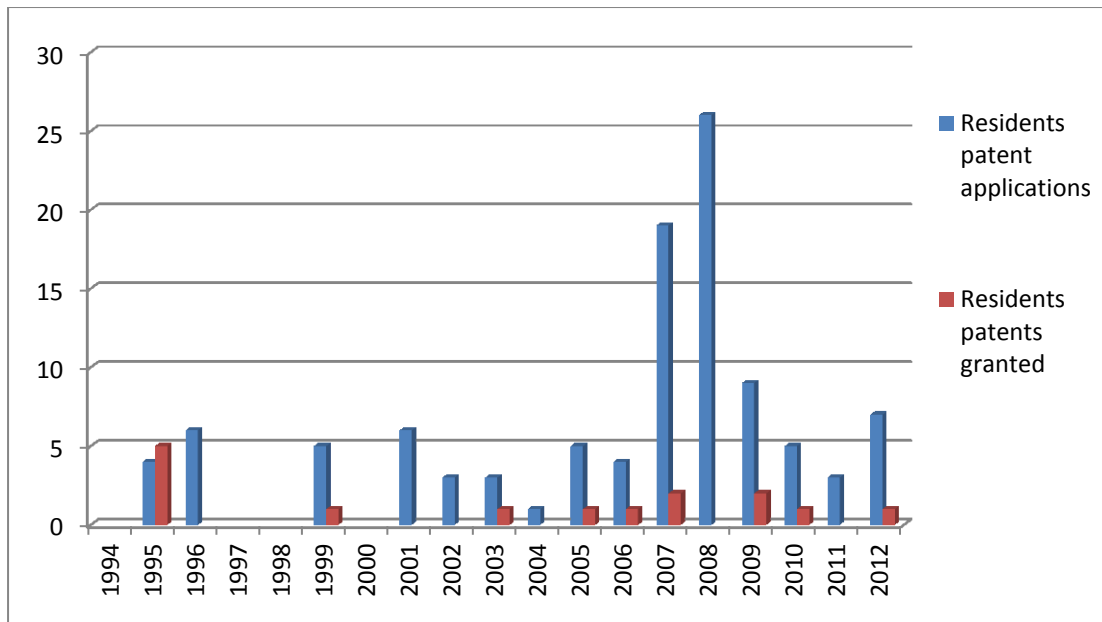


Figure 31: Patent data for residents from 1994. Source: WIPO Statistics Database.

#### 4.3 National Policy on Science and Technology

The science and technology policy was implemented in 1996, and remained in force beyond 2012. The country had moved from being a command driven economy where government controlled business to a market driven economy with more private led enterprises. Although government privatised almost all of the state owned enterprises, the research institutions were still publicly funded and owned. This left a vacuum in terms of technology transfer.

The strategies of the policy included changing the institutional structure of the NCSR; ensuring that research is guided by national developmental goals; establishing a mechanism for increased innovation, transfer, diffusion and commercialization of technology, especially for small and medium scale industries, with emphasis on indigenous technology; enhance linkages between technology research institutes, the private as well as the public sector in order to encourage demand driven research and development; and to provide highly skilled human resource for increased productivity in the economy.<sup>102</sup>

It aimed to achieve this by splitting up the functions of the NCSR into a government agency that will co-ordinate and fund research in the country (National Science and Technology Council), an agency that would transfer technologies or research outputs from research institutions to industry (National Technology Business Centre), and research institutions that

<sup>102</sup> Ministry of Science, Technology and Vocational Training. 1996. *National Policy on Science and Technology*. Lusaka

would carry out actual research (only one was formed at the time – National Institute for Scientific and Industrial Research).

A science and technology fund, and a venture capital fund would be started. The science and technology fund would get contributions from both the private and public sector, and the allocation of funds would fall to an industry led board of directors with the National Science and Technology Council (NSTC) acting as secretariat. The venture capital fund would get contributions from the private sector, and would be managed by the National Technology Business Centre (NTBC).

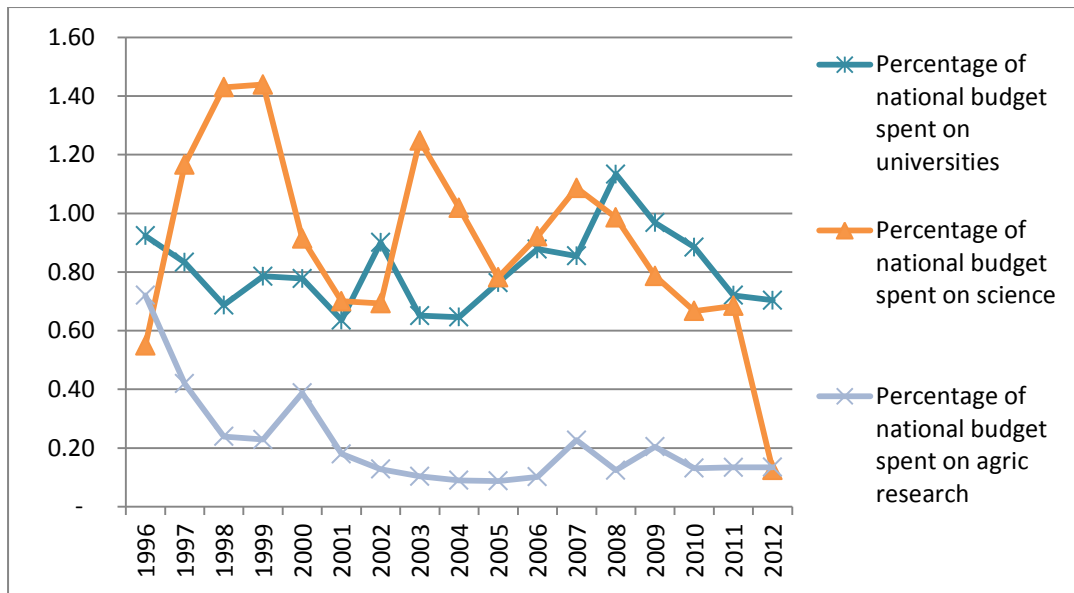
The science and technology policy had sectorial research goals. For the agriculture sector the policy aimed to direct research efforts into the generation of better crop and livestock products for all major agro-ecological zones of the country; strengthen capabilities for livestock research in diseases, husbandry practices, breeding and nutrition, and strengthen research/extension/farmer linkages.<sup>103</sup> The strategy for the industrial sector was to equip laboratories with additional equipment and, to identify locally available raw materials for use by industries.

#### **4.3.1 Budget, Expenditure and Top Export Products**

The amount budgeted for under universities is almost the same as that for the science sector. The science sector includes the ministry of science, technology and vocational training, and the institutions that fall under it. The science policy of 1996 created three institutions namely the National Science and Technology Council, the National Technology Business Centre, National Institute for Scientific and Industrial Research.

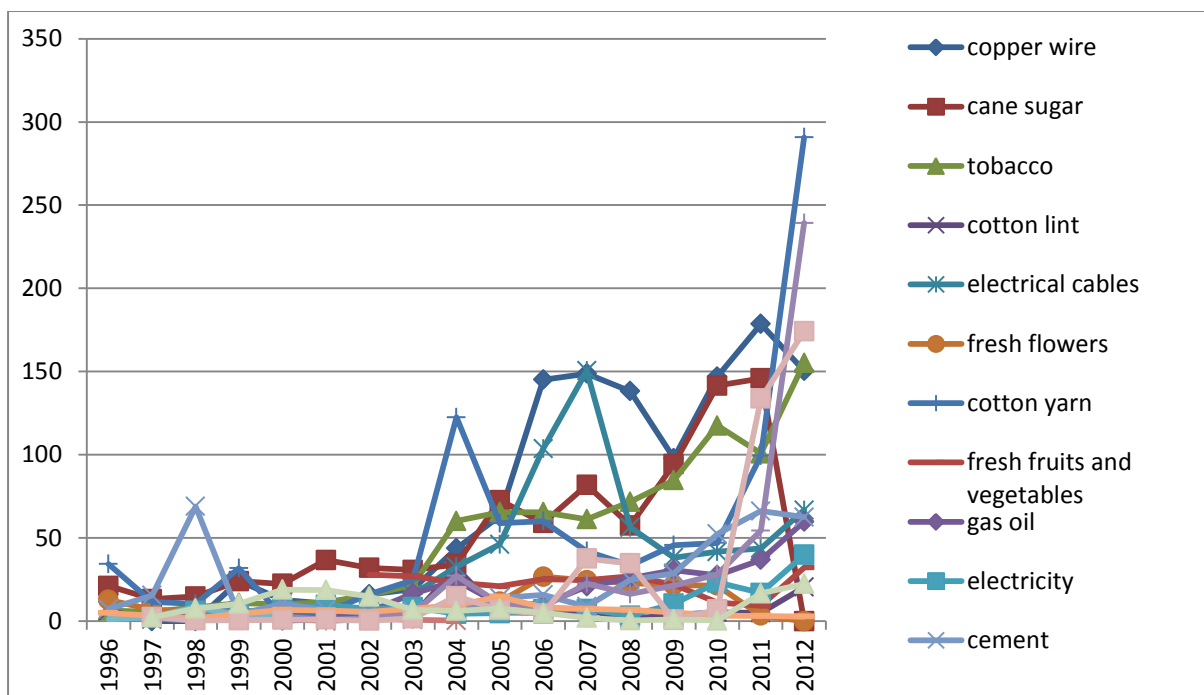
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<sup>103</sup> Ministry of Science, Technology and Vocational Training. 1996. *National Policy on Science and Technology*. Lusaka



**Figure 32: Proposed Expenditure for 1996 to 2012**

Figure 31 shows the goods exported during the period. It can be noted that the country began exporting maize flour from maize, and cotton yarn from cotton lint.

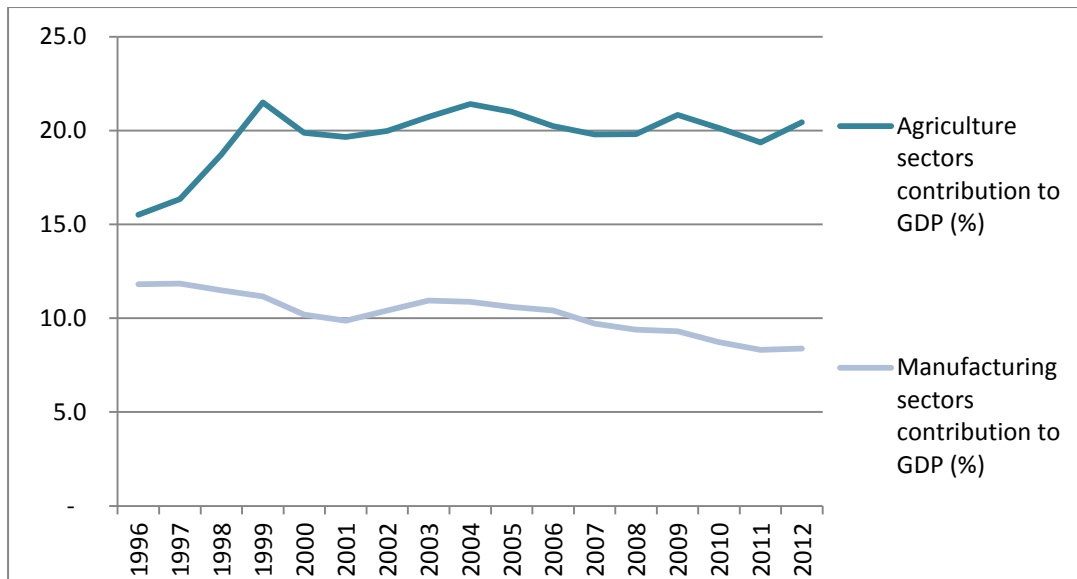


**Figure 33: Exported products in the agriculture sector during the period (in K 'millions)**

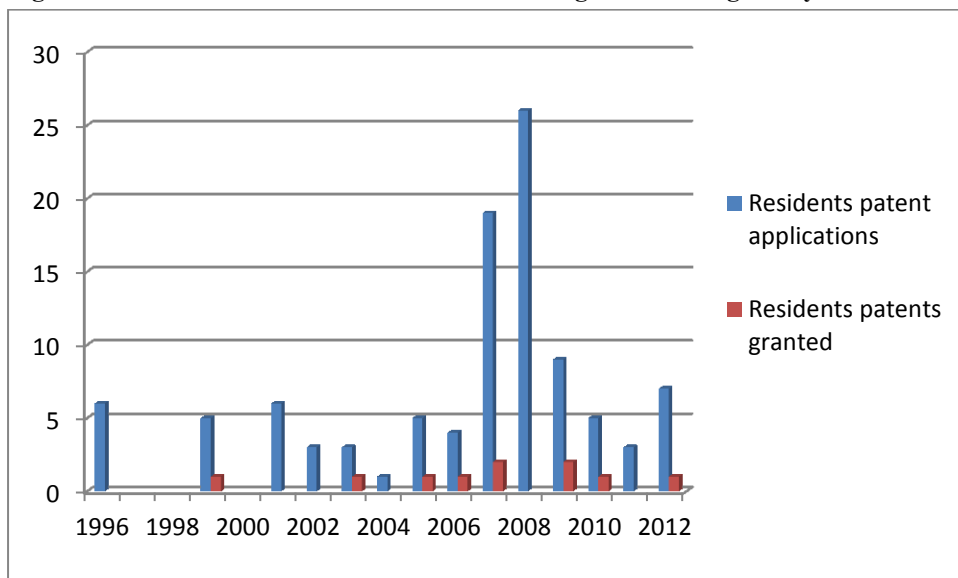
#### 4.3.2 Contribution to GDP Comparison and Patents

While the agriculture sector's contribution to GDP remained fairly stable, the manufacturing sector's contribution showed a steady decrease.





**Figure 34: Sectors contribution to GDP and GDP growth through the years.**



**Figure 35: Patent data for residents from 1996. Source: WIPO Statistics Database.**

#### 4.4 National Agriculture Policy

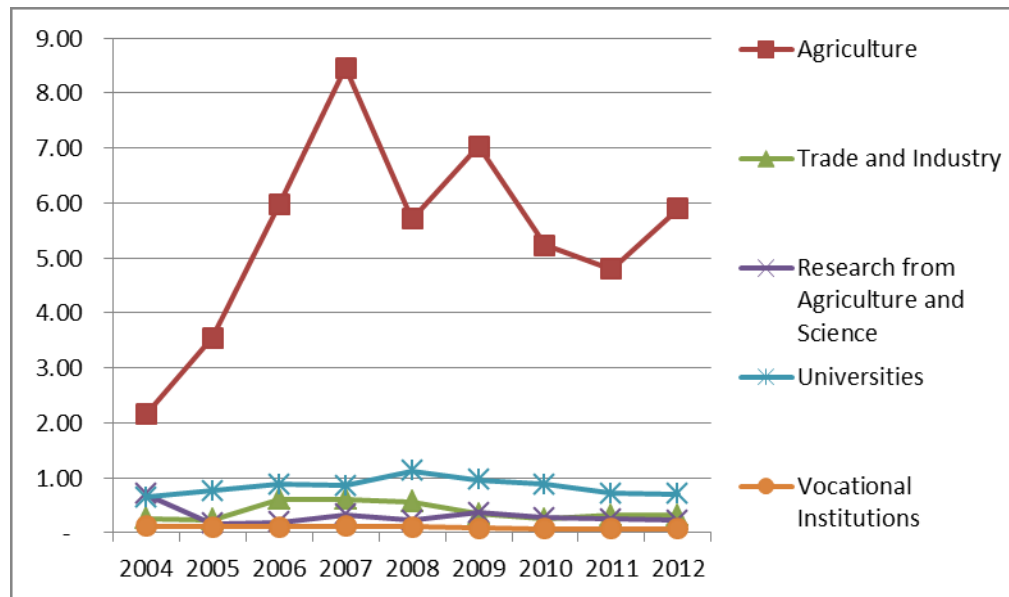
The Agriculture policy was from 2004 to 2015 and aimed to provide agro-based raw materials to the industrial sector, increase agriculture exports, generate income and employment as the sector was the biggest employer, and to increase national and household food security<sup>104</sup>. In terms of research the focus would be on developing crop varieties that the private sector would find uneconomical such as maize, sorghum and millet. The development of other economical crops would be done in collaboration with the private sector. Livestock research would concentrate its resources on the development of vaccines and/or medicines for

<sup>104</sup> Ministry of Agriculture and Co-Operatives. 2004. *National Agriculture Policy*. Lusaka..

domestic animals, characterize indigenous livestock breeds, promote their conservation, and conduct investigations on the nutritional status of livestock in the traditional sector.

#### 4.4.1 Budget, Expenditure and Top Export Products

Once again the government allocation towards agriculture remained high though it saw a steady decline during the latter half of the study. (figure 35). The government allocation towards universities also remained at a stable rate.



**Figure 36: Proposed Expenditure for 2004 to 2012**

Figure 35 shows the goods exported during the period. The country still primarily exported agricultural products. There was an increase in the variety of agriculture products but however, there were no corresponding increases in the manufacturing sector.

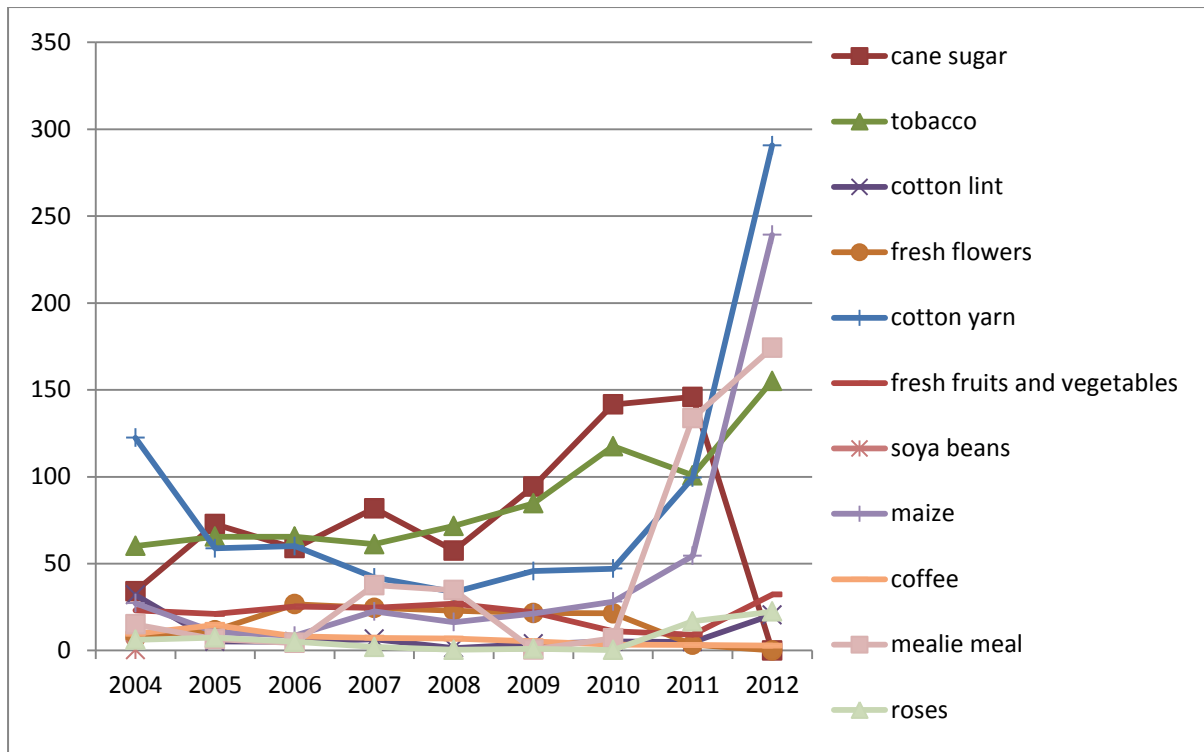


Figure 37: Exported products in the agriculture sector during the period (in K 'millions)

#### 4.4.2 Contribution to GDP Comparison and Patents

Goods exported during the period show an increase in the value received. Even the traditional agricultural exports did well. However the agriculture and manufacturing sector's contribution to GDP saw a negative trend.

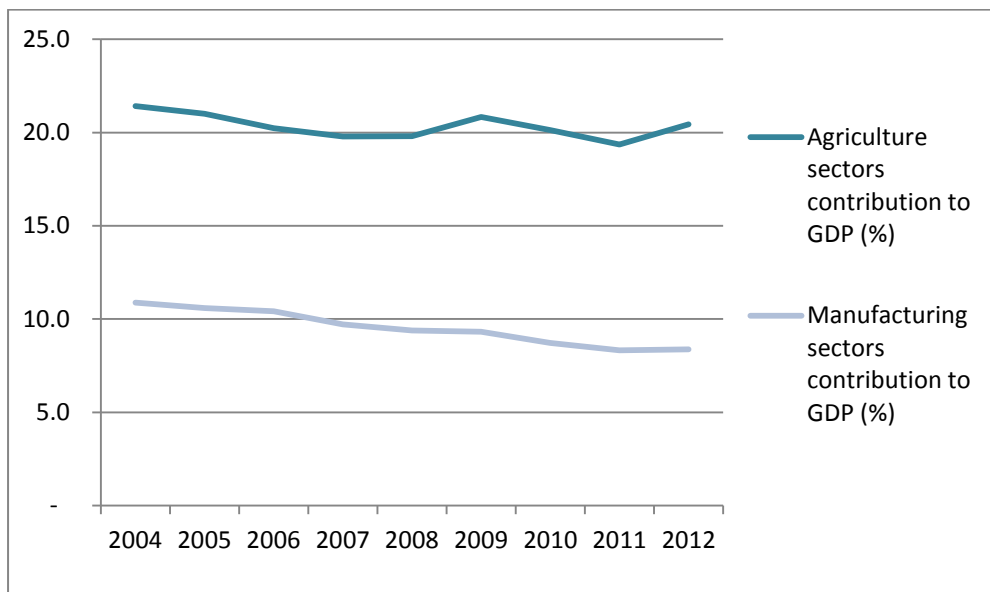


Figure 38: Sectors contribution to GDP and GDP growth through the years.

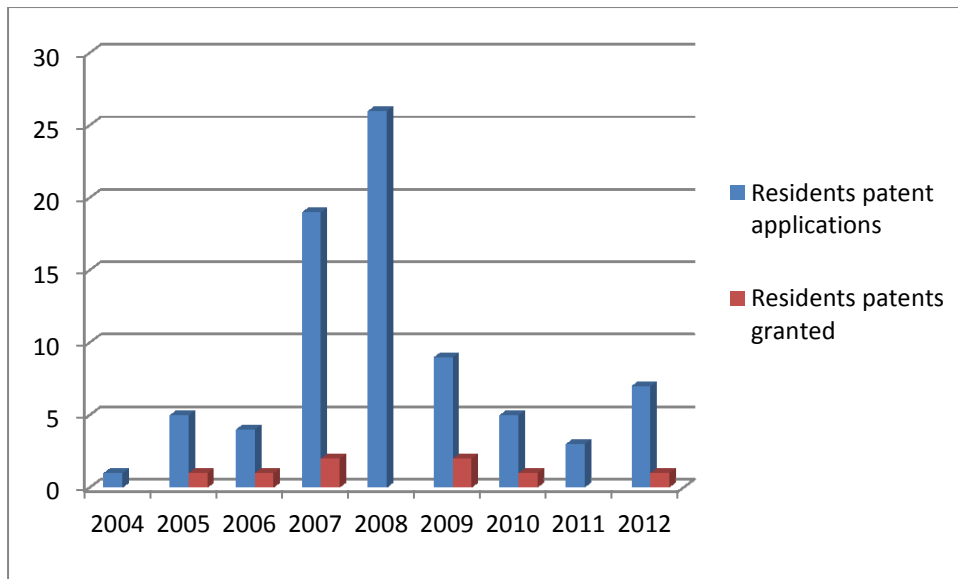


Figure 39: Patent data for residents from 2004. Source: WIPO Statistics Database.

#### 4.5 Policy: Fifth National Development Plan

From 1991 development planning was abandoned in favour of an open market system. However, it was realised that even in a liberalized economy, development planning was necessary. Therefore, the country implemented the Fifth National Development Plan (FNDP) from 2006 to 2010.<sup>105</sup> It should be noted though that apart from the national development plans sectors came up with policy documents to guide their activities. Poverty alleviation was the key focus of the FNDP as 68% of the population lived below the poverty line. To counter this, the government decided to concentrate its efforts in the agricultural sector as 60% of the population derived its livelihood from farming. Agriculture was also seen as a way of increasing the incomes of people in the rural area. In addition the plan would also allocate resources to infrastructure development, especially roads, schools and hospitals in the rural areas. The aim, in the agriculture sector, was to strengthen the extension programme to help small scale farmers increase their yield, open up farming blocks for commercial farmers and to encourage the diversification of staple and cash crops.

In 1991 the country moved from a mainly public driven industrial sector to private enterprises. Many of the state owned companies were privatised. Therefore, the strategies highlighted in the plan for the manufacturing sector included, among others, creating a conducive environment for private enterprises to flourish and to increase and diversify

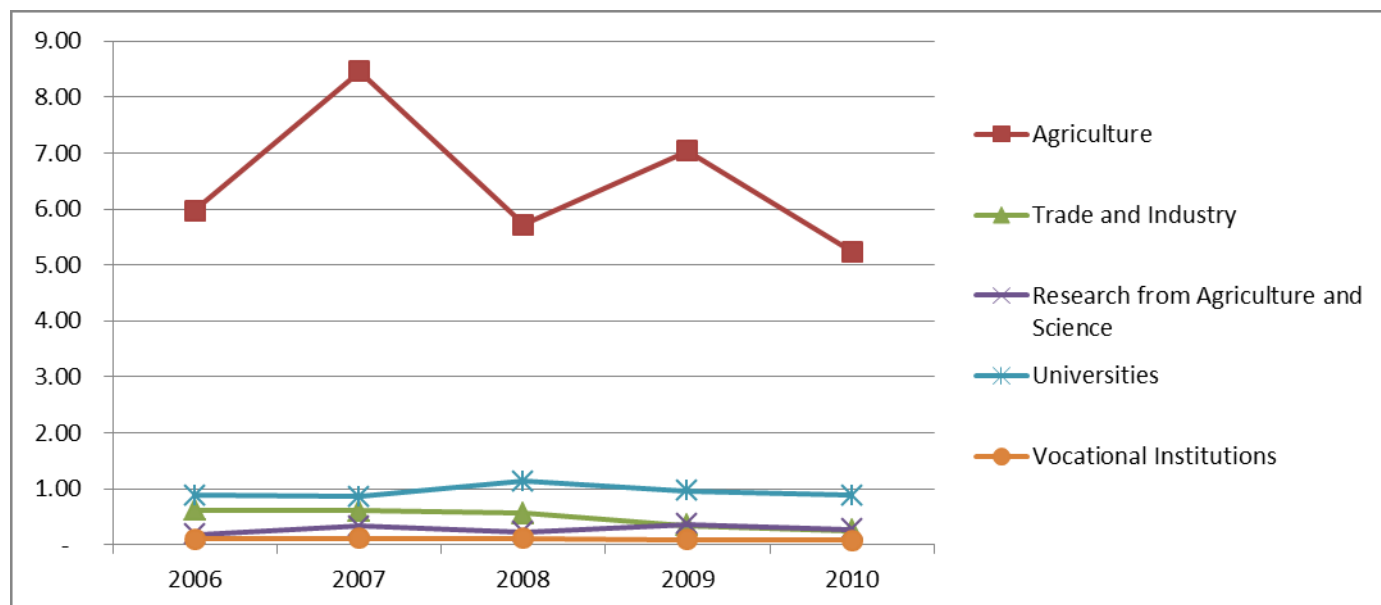
<sup>105</sup> From Ministry of Finance and National Planning. 2006. *Fifth National Development Plan 2006 – 2010*. Lusaka

exports. The government would encourage activities based on the agro-processing and mining sub-sectors.

The FNDP had a section principally for science and technology. However, the institutions involved did not plan for research activities of the other sectors as in the previous plan. The Fifth National Development Plan aimed to increase the human resource base of researchers in the country, to improve the research facilities such as laboratories, increase funding for research and development, and improve the commercialization of research and development outputs. It should be noted that despite the liberalization of the economy, research activities were still principally funded by government.

#### 4.5.1 Budget, Expenditure and Top Export Products

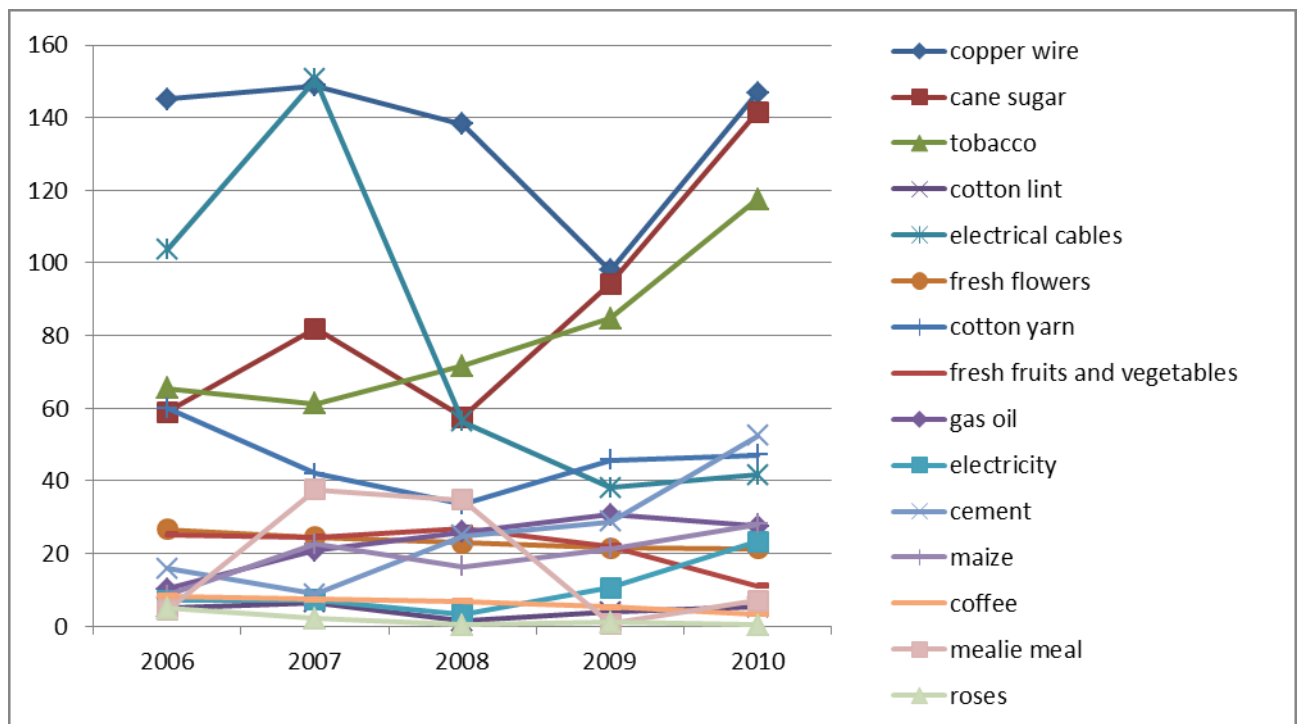
During the FNDP the amount spent by the government on trade and industry drastically reduced. This reflects the change in policy from mainly government run business to private ownership. The amount spent on research in both agriculture and science was below 1%.



**Figure 40: Proposed Expenditure for 2006 to 2010**

Exports during the period consisted mainly of raw materials with little to no value addition.

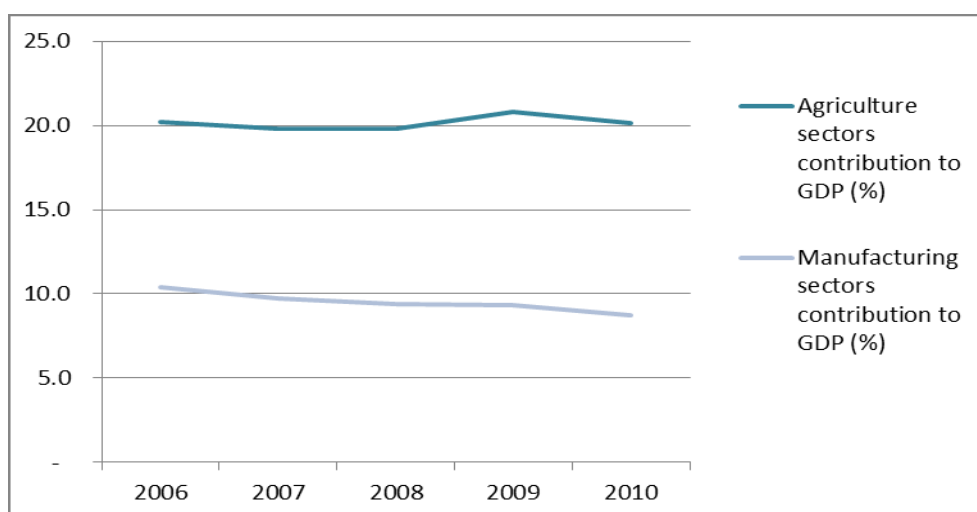
The figure below shows the exports in the agricultural sector during the period.



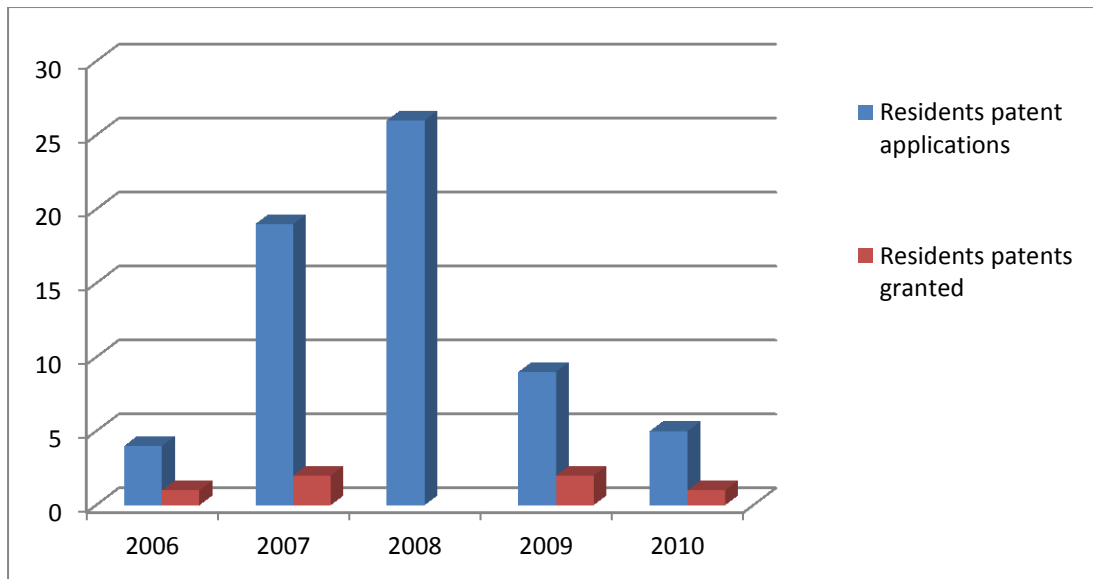
**Figure 41** Exported products in the agriculture sector during the period (in K 'millions)

#### 4.5.2 Contribution to GDP Comparison and Patents

The amount spent on agriculture in the national budget is reflected in the indicators under the study. Agricultural products (crops) such as maize and tobacco saw an increase in the value received in terms of export revenue. This can also be seen in the agriculture sectors contribution to GDP. However the manufacturing sector did not fare well, showing a steady decline in terms of the sector's contribution to GDP, but exported products show an increase in the number of manufactured products exported.



**Figure 42:** Sectors contribution to GDP and GDP growth through the years.



**Figure 43: Patent data for residents from 2006. Source: WIPO Statistics Database.**

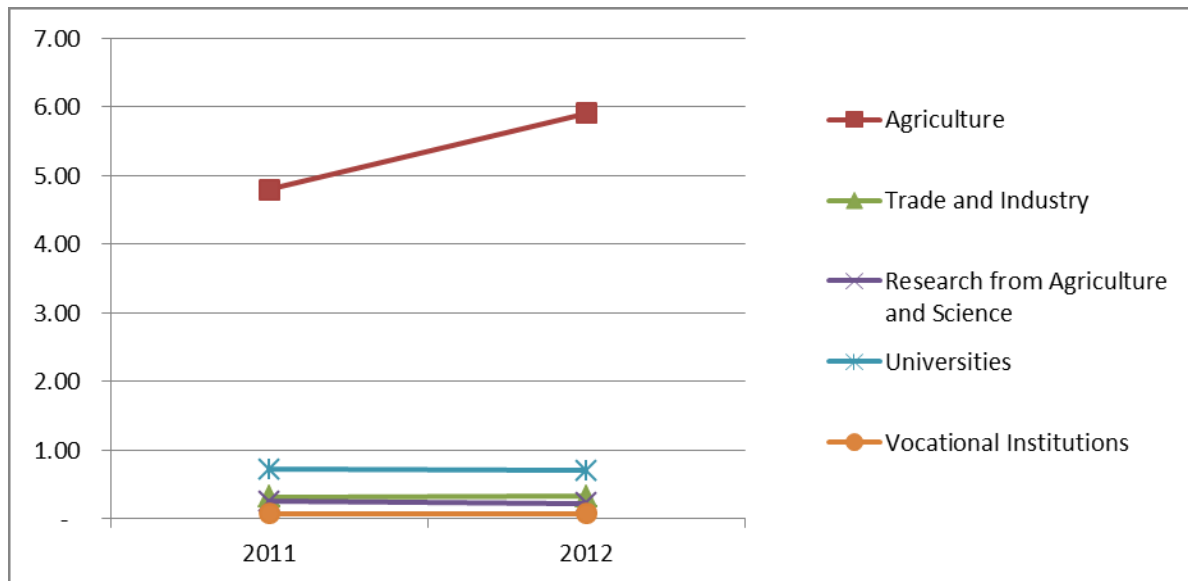
#### **4.6 Policy: Sixth National Development Plan**

The Sixth National Development Plan (SNDP) ran from 2011 to 2015. As the period to be reviewed only covers the remaining two years of this study, not much will be highlighted in terms of sector plans. However the SNDP sought to continue on the efforts of the previous plan as agriculture would remain the priority sector to reduce poverty, create employment and promote economic growth.

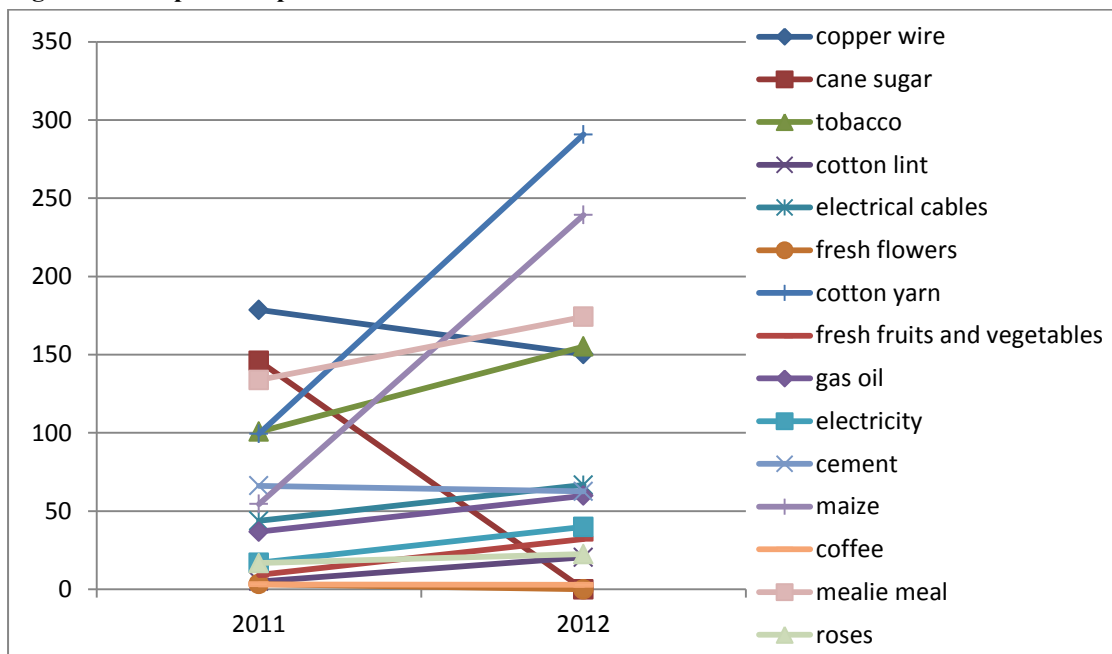
In the manufacturing sector the government aimed to encourage the private sector to develop industries by creating a conducive environment in which to do business through incentives, and policy changes. The science sector was mainly uncoordinated, and unplanned for in the SNDP. No government agency or ministry specifically planned for research activities. However this was noted and one of the strategies of the plan was to change the institutional framework of the institutions tasked to manage, and coordinate research in the country. The strategy also included increased linkages between research institutions and industry, and an increase in the human resource base in science and technology institutions of government. With the privatisation of state owned industries and the establishment of private companies, research institutions found it difficult to transfer their research outputs.

##### **4.6.1 Budget, Expenditure and Top Export Products**

During the plan, the government allocation towards agriculture remained high in comparison to the other indicators. The country exported a lot of crops but very little in terms of value addition was noted.



**Figure 44: Proposed Expenditure for 2011 to 2012**

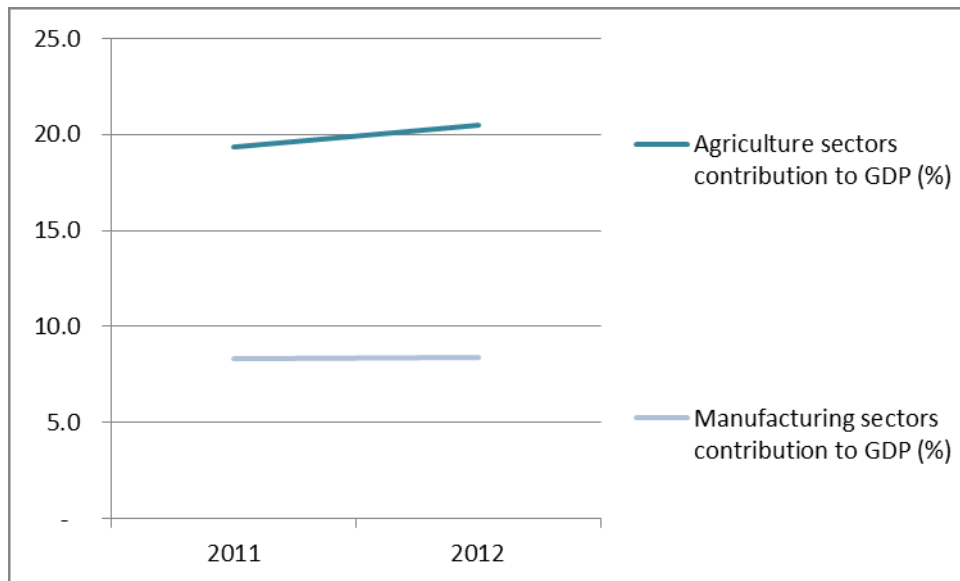


**Figure 45: Exported products in the agriculture sector during the period (in K 'millions)**

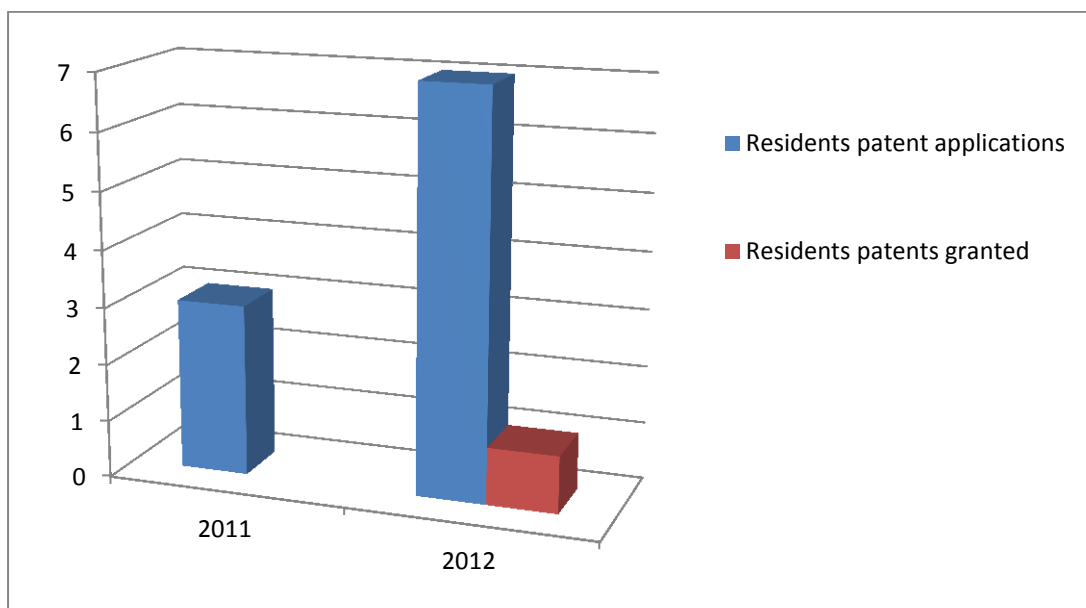
#### 4.6.2 Contribution to GDP Comparison and Patents

The agriculture and manufacturing sector's contribution towards GDP remained mostly the same in the years 2011 and 2012.





**Figure 46: Sectors contribution to GDP and GDP growth through the years.**



**Figure 47: Patent data for residents from 2011. Source: WIPO Statistics Database.**

#### **4.7 Conclusion**

In 1991 a free market system was introduced, and the government policy moved from mostly state owned enterprises to privately owned. To that end, most state owned businesses were sold. In addition, price controls, were also lifted.

The Ministry of Science and Technology was established under which NSTC, NTBC, NRSC and NISIR fell. ZARI, the public research institution that conducted agriculture research, fell under the Ministry of Agriculture. In addition universities fell under the Ministry of Education. Therefore, the institution tasked with coordinating the sector (NSTC) faced

challenges as each research institution could lobby central government for research funds through its line ministry.

Using Linsu Kim's adapted model (figure 48) to compare the indicators it shows that a few products were exported that had added value; for example from maize to mealie meal and from cotton lint to cotton yarn. However, the country was still predominantly an exporter of raw materials. In addition the amount earned by the country (in US\$) has been steadily increasing.

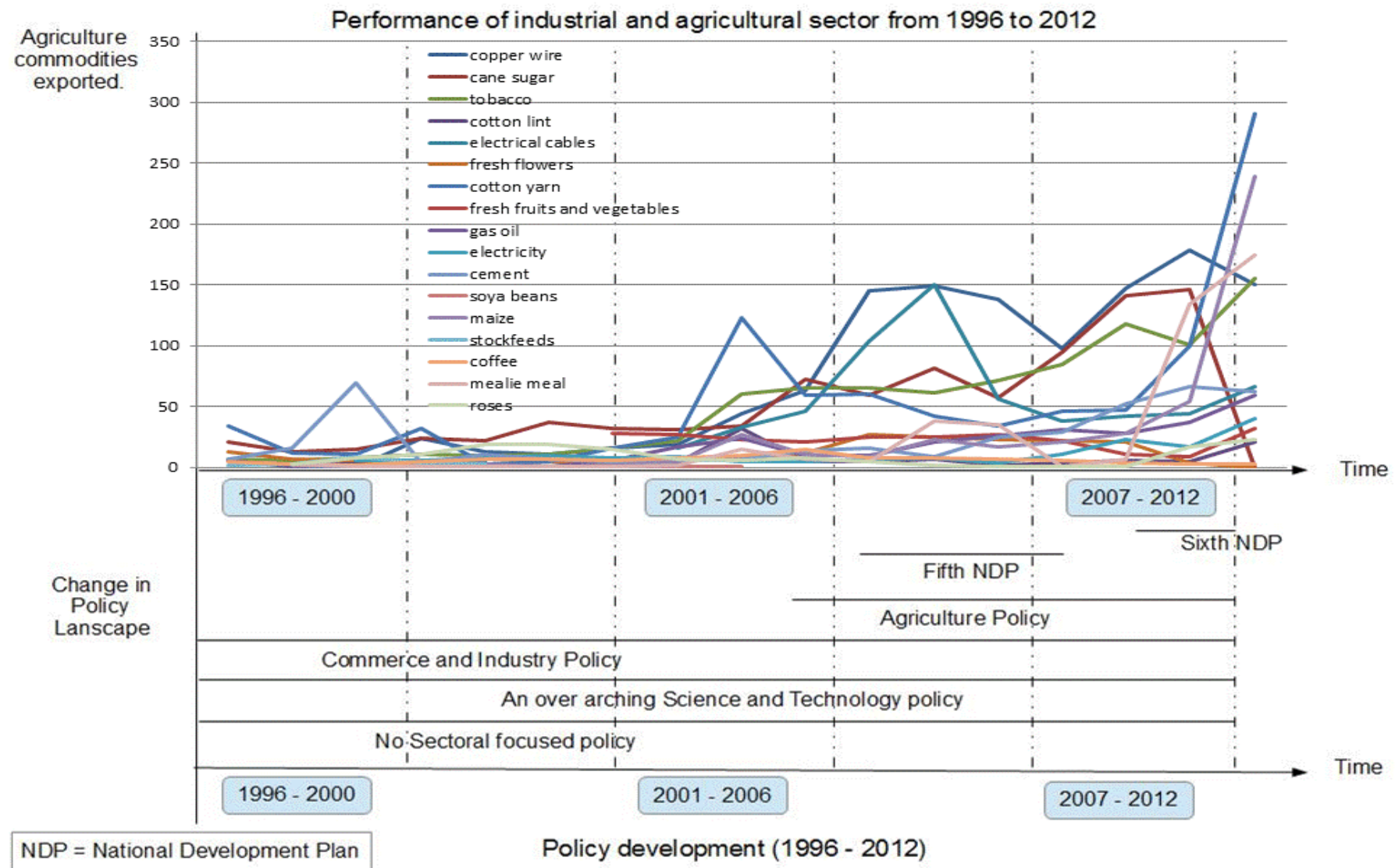


Figure 48 Linsu Kim's adapted model showing goods exported and the policy landscape.

# *Chapter Five*

## Comparison and Analysis

### **5.1 Introduction**

Zambia has a total of twenty line ministries, half of which are involved in science and technology research. They include;

1. Ministry of Agriculture and Livestock
2. Ministry of Health
3. Ministry of Defence
4. Ministry of Commerce, Trade and Industry
5. Ministry of Community Development, Mother and Child Health
6. Ministry of Education, Science, Vocational Training and Early Education
7. Ministry of Gender and Child Development
8. Ministry of Land, Natural Resources and Environmental Protection
9. Ministry of Mines, Energy and Water Development
10. Ministry of Tourism and Arts

The draft policy acknowledged the following shortcomings (among others) in the 1996 Science and Technology policy, namely:

1. “The coordination of Science and Technology programmes across the line Ministries. Although the NSTC was established as the coordinating organ for the sector, the effectiveness of the coordination system has been hampered by inadequate legislation, lack of rationalisation in programming, disjointed and incoherent funding to research and development, and the absence of a common planning process and platform between the line Ministries and other key stakeholders.

2. The key R&D institutions in the country are found in the public sector. The main focus of the research institutions is restricted to the mandate of the line ministries to which they belong as they obtain funding, and policy guidance from their line Ministries.
3. There is insufficient collaboration and rationalisation of resources between the Universities and R&D institutions. This has resulted in duplication of efforts thereby increasing the cost of research.

The draft policy makes significant changes to the current STI framework and the structure of the country's national innovation system.

## **5.2 Funding of science and technology**

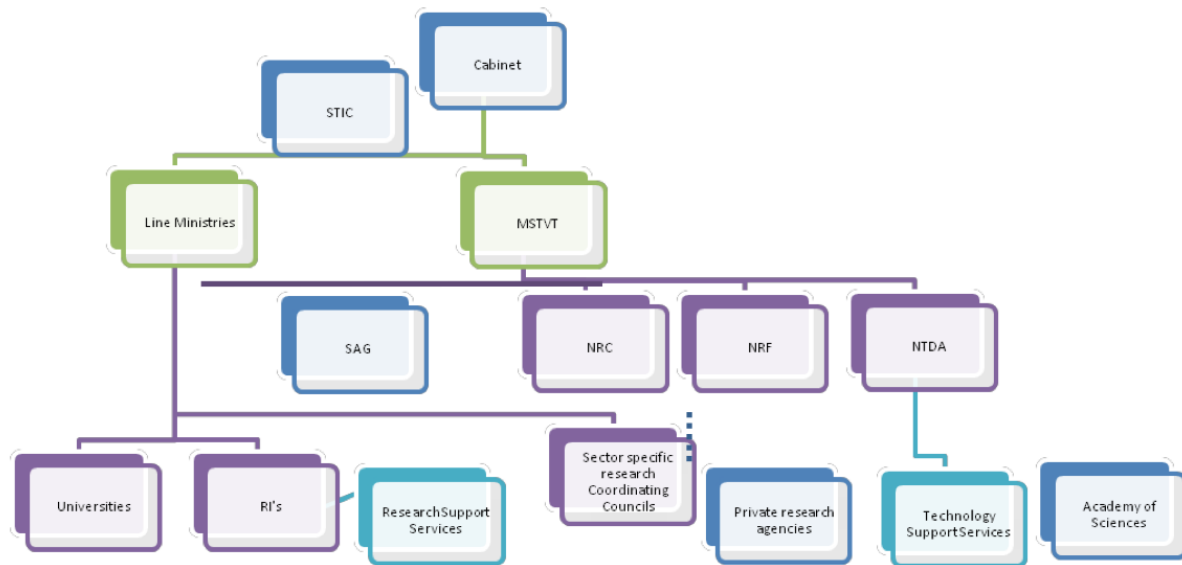
The draft STI policy lists the following reasons for funding problems in the sector during the life of the 1996 policy

“The research funding mechanisms are fragmented and inappropriate for the goal of addressing a nationally determined research agenda. This has led to duplication of efforts and wastage of resources, which has also led to a challenge in collecting data on the actual investments into research and development. Research institutions also receive funding from external sources such as multilateral and bilateral agencies, foreign universities, charitable organisations and international philanthropists. However, this source of funds has tended to tilt the research agenda to respond to the priorities of external funding sources.”<sup>106</sup>

The draft policy seeks to enhance the coordination and visibility of the science sector by elevating the position of the coordination and resource allocation organ of the current national innovation system, the aim being, to strengthen the sector and enable resource allocation.

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<sup>106</sup> Ministry of Science, Technology and Vocational Training. 2009. Final Draft *National Science, Technology and Innovation Policy*. Lusaka.



**Figure 49 Proposed structure of the NIS**

Figure 49 shows the proposed structure of the NIS. ‘The Government will establish a platform for Science, Technology and Innovation to be called the Science, Technology and Innovation Council (STIC) to be chaired by the Republican Vice President. The Council shall be the central and lead body for all matters pertaining to science, technology and innovation in Zambia. It will provide policy direction and spearhead policy implementation and ensure that Government makes available the resources needed to build a vibrant and sustainable science, technology and innovation system. STIC will meet at least twice a year to determine direction and evaluate the implementation of STI.’<sup>107</sup> One of the functions of the STIC will include among other things to prescribe the budgetary allocation for science, technology and innovation from central government.

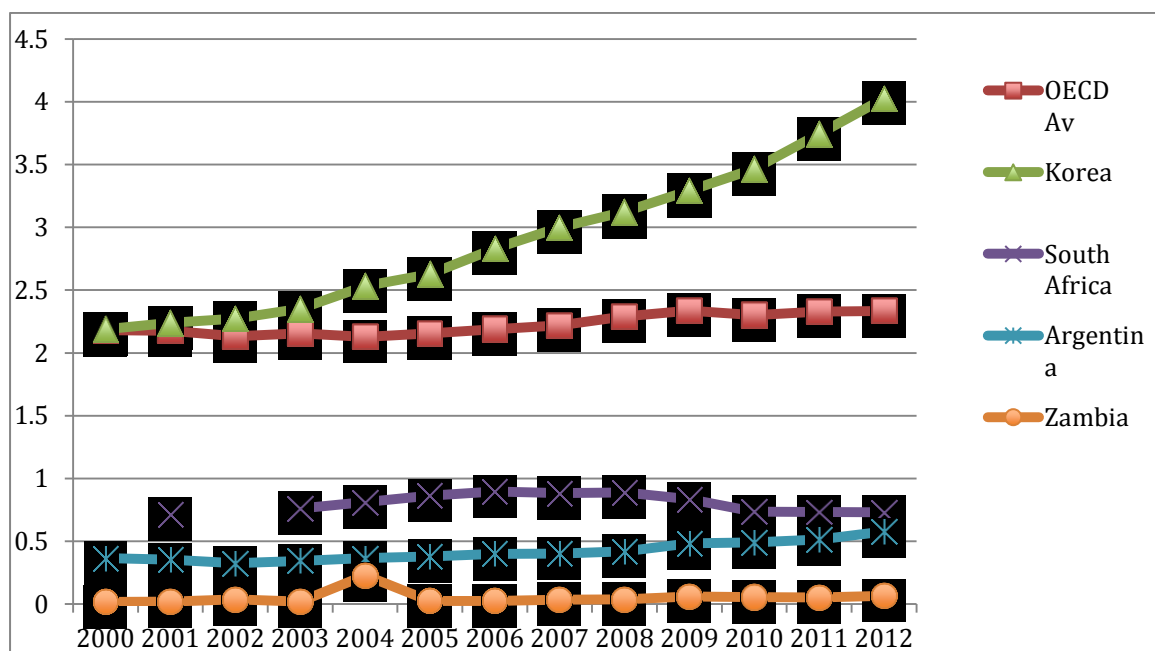
### 5.3 Comparison with other Countries

Ideally one wants to compare Zambia with similar countries. However, the lack of data that besets the Zambian case, and which necessitated alternative strategies in this thesis, will also be apparent for most comparable countries. In other words, there is no readily available data from an equally comparable country. For this reason, this section resorts to an unequal comparison with country’s with larger economies and more complete statistics. It will give a sense of the scale of the Zambian situation.

<sup>107</sup> Ministry of Science, Technology and Vocational Training. 2009. Final Draft *National Science, Technology and Innovation Policy*. Lusaka.

The table below shows the country's performance in terms of amount spent on Research and Development as a percentage of GDP with other countries in the region. However due to the scarcity of data available in Southern Africa, South Africa was the only country that could be used. However as an additional comparison Argentina and Korea's GERD percentage of GDP was used. The graph also plots the OECD average in terms of GERD as a percentage of GDP.

In addition the only available data is from the year 2000 to 2013. This therefore provides a brief comparison of what is happening in the region in terms of expenditure on research and development. It however gives a short picture of what is happening globally in the sector.



**Figure 50 Comparison GERD**

As the graph above shows, the amount spent on R&D as a percentage of GDP is well below the OECD average and also below the newly industrialised nations. Apart from the spike in 2004 the amount spent on research and development as a percentage of GDP has remained relatively constant. The spike in 2004 can be attributed to the jump in funding from 0.08% to 0.82% of the national budget. That is government funded science and technology institutions (that is National Science and Technology Council - NSTC, the National Technology Business Centre - NTBC, National Institute for Scientific and Industrial Research - NISIR, and the National Remote Sensing Centre - NRSC) all received an increment in their budgetary allocation for the year. In addition the government placed funds in the Science and Technology Venture Capital Fund and set up and funded two research grants, the Youth Innovation Fund and the Strategic Research Fund.

It should be noted that the figures used to plot the graph above for Zambia include the amount spent by the country on science and technology in general and not research budget per se. The research funds above were only listed in the *Government of the Republic Of Zambia - Estimates of Revenue and Expenditure* for the years 2004 and 2006.

In addition as can be seen in the graph above the amount spent on the science and technology in general did not meet the 3% goal as set in 1996 (in the current STI policy). The aim was to spend 3% of GDP on science and technology programmes.

#### **5.4 Findings of the Study**

Further more funding to the STI sector can be divided into two aspects namely:

1. The amount spent on science and agriculture research in the two eras
2. The amount spent on science in general that is Ministry of Science and National Council of Scientific Research.

In order to answer the question which national innovation system received a greater percentage of Government Budget Appropriations for R&D (GBAORD).

#### **5.5 Amount Spent on Science and Agriculture Research**

The planning in the first National Innovation System was done via National Development Plans, as can be seen in figure 51. The government was allocating 0.2% to as much as 1% of the national resources towards agriculture research. However the funding towards research in the sector saw a marked increase within or at the beginning of the national development plans. The same trend can also be observed in the science sector, which saw a steady increase from 0 to 1.4%. In each subsequent national development plan in the era, funding to science research saw a marked increase. The appreciable jump from 0.3% in 1991 to 1.4% in 1992 was due to the establishment of the Ministry of Science and Technology in that year. The government funded initial setup costs such as buildings, equipment and furniture.

The funding towards the NIS from 1996 to 2012 in the science sector reached a high of 1.4% and then steadily declined to below 0.2%. This trend was also observed in the agriculture sector. From an allocation of 0.7% of the national budget it fell to about 0.1%. An increase in the allocation was observed after the launch of the 5<sup>th</sup> and 6<sup>th</sup> national development plans.

What has been observed in this analysis is that the office to which the overall arm of research in the country reports to does not determine the influence that the sector has towards government appropriations. However what affected funding towards the sectors (both



agriculture and science) are the national development plans. When policy instruments were used to determine government appropriations two to three years after the launch of the policy government appropriations reduced. As policy instruments had no lifespan and could be used indefinitely the funding towards the sector reduced in subsequent years due to competing needs. However with the introduction of the 5<sup>th</sup> national development plan in 2006 the same trends were noticed as in the previous national innovation system (from 1964 to 1995).

### **5.6 Comparison of amount spent on science in general**

As figure 50 shows the comparison between the NIS (1964 to 1995) and the NIS (1996 to 2012). In the previous segment (6.5) the National Council for Scientific Research saw a steady increase in funding from 0 to 0.35%. In every new national development plan there was an appreciable increase in the percentage allocation to the institution. This was in contrast to the funding to the Ministry of Science and Technology which saw a high of 1.2% and by the end of the study it had declined to less than 0.2%.

The same pattern is noticed in the funding towards the institutions as in the previous section. Directly after the launch of the science and technology policy the Ministry receives a generous percentage of the government funds from treasury. However the percentage allocation does not increase but visibly reduces (Figure 50). It was also observed that funding towards the ministry noticeably increased after the national development plans (both the 5<sup>th</sup> and the 6<sup>th</sup>).

### **5.7 Comparison of actual amounts spent from financial reports**

Financial reports for every year are produced by the Ministry of Finance. The reports indicate the amount budgeted for, any supplemental funding, the actual amount disbursed and the variance – that is the difference between the amount disbursed and the amount budgeted for. Reports were collected for the years 1999, 2005, 2009, 2010 and 2011.

The reports show that for all the years there was a variance. That is the amount budgeted for was more than the expenditure. However from the reports it is impossible to tell whether the variance is due to the amount not being disbursed or it is because the project was not implemented. This is because all money disbursed but not utilised by line ministries is sent back to treasury at the end of every financial year.

### **5.8 Recommendations**

This chapter uses descriptors (as highlighted by Gailliard) and science indicators to find which national innovation system would be able to attract a greater percentage of GBAORD.

Using figure 51 and 52 to compare the indicators, what has been observed is that the office to which the institution reports does not determine how much influence the sector receives from government treasury. However what has been observed from the study is that the national development plans influence allocation of monetary resources by the treasury. If the NDPs determine that for the next five years the country will spend more towards the agriculture and/or science sector the government appropriation will reflect this, as was seen in the fourth national development plan (section 3.4).

Using figure 51 and 52 to compare the indicators it has been found that the amount allocated for research in the national budget for the agriculture and science sectors was greater in the NIS that spanned 1964 to 1995 than the NIS that spanned 1996 to 2012. This could be because the national development plans emphasised agriculture as the main area for diversification of the economy, and research centres were to come up with crop varieties that would increase harvests. In comparison no national plan existed in the later NIS, however policies that drove the sectors were not able to influence budgetary allocations to a certain extent in the same way.

The amount allocated towards science in general was greater in the NIS that spanned 1996 to 2012 than the NIS that spanned 1964 to 1995. This could be because more institutions existed under this system; it included the National Science and Technology Council (NSTC), the National Technology Business Centre (NTBC), the National Institute for Scientific and Industrial Research (NISIR), and later the National Remote Sensing Centre (NRSC). All the institutions received a maximum of 1.1% of the national budget, which amounts to 0.3% if divided equally. It should also be noted that with the splitting of the functions of the National Council for Scientific Research (NCSR) it was possible to tell how much funding went to research institutions and to regulation of research under the science sector.

In addition it is also possible to see that after the launch of each development plan the appropriation improved. In comparison an increase in the allocation to the sectors was only noticed after the launch of a policy, then, the percentage allocation steadily waned. Small increases in the budgetary allocation were noticed after the launch of the fifth and sixth national development plan.

The NIS 1996 to 2012 reflects the shift in government policy. Furthermore with the change it is also possible to tell how much is going to actual research as the government set up various research funds; for example, the Science Technology Development Fund and the Strategic

Research Fund with the aim that budgetary allocations towards research institutions would go to emoluments, building maintenance, and general administration while the amount allocated to research funds would be used to specifically fund research projects. Research institutions were to apply for the funds and projects would be chosen based on merit. However, the NIS 1996 to 2012 could not greatly influence the amount allocated to research institutions and to the science sector as a whole as the sector saw a steady decline in the appropriations received.

It has been observed that both national innovation systems had merits and demerits and combining the strengths of the two systems for the third NIS would see a much more resilient system.

Using the adapted model to compare exports it can be noted that the value of exports steadily rose from \$300,000 to over \$250,000,000.00 in non-traditional exports, in addition the country began exporting more varied products like electricity, and stock feeds. Value addition was noted in products like maize to maize flour, coffee beans to coffee and cotton lint to cotton yarn; furthermore products like roses and fresh flowers show the use of agricultural technology. It has been shown that industries are learning and are adding value to raw materials. However, the monetary value received from non-traditional exports is still small in comparison to that received from the mining sector. The country is still heavily dependent on the mining sector for revenues.

Despite the positive trend the aims of the national development plans remain largely unrealised; that is, an improvement in the livelihoods of the people in the rural areas through agriculture, making agriculture products the main export earnings for the country and to grow the manufacturing sector through import substitution.

This study shows that what influences the amount allocated to each sector in Zambia is the five year planning cycle. Having said that, for science to influence GBAORD during the next planning phase of the national development process, the science sector would have to move to a higher office or be placed as a department of the National Development Planning Office - as was the case with the decentralisation policy. Under the Ministry of Community Development, Mother and Child Health the policy was not making any headway. Now that the policy is under Cabinet office, a planned role out has now been established with a targeted date for decentralisation to be implemented.

# *Chapter Six*

## Discussion and Contextualisation

### **6.1 Introduction**

The policies that governed government allocation of resources and planned activities have been studied in the previous chapters. This chapter compares and contrasts the two national innovation systems using Linsu Kims dynamic model using the narratives and descriptors as proposed by Gailliard. The chapter has been broken down into the following sections:

1. Compare the amount spent on science and agriculture research in the two eras.
2. Compare the amount spent on science in general that is Ministry of Science and National Council of Scientific Research.
3. Compare the patents produced in the two eras.
4. Compare exports between the two eras.

### **6.2 Comparison of Amount Spent on Science and Agriculture Research**

The figure 51 below shows the amount spent on science and agriculture research from 1964 to 1995. The amount budgeted for science research as a percentage of the national budget shows a steady increase from 0 to a high of 1.45%, despite the fluctuations shown in the graph. The same cannot be said for the allocation towards agriculture research. The graph shows that the amount allocated as a percentage of the national budget varied every year but almost always fell between 0.2% and 1%. Overall the government allocated money towards agriculture and science research with a favourable trend being seen during the 4<sup>th</sup> National Development Plan.

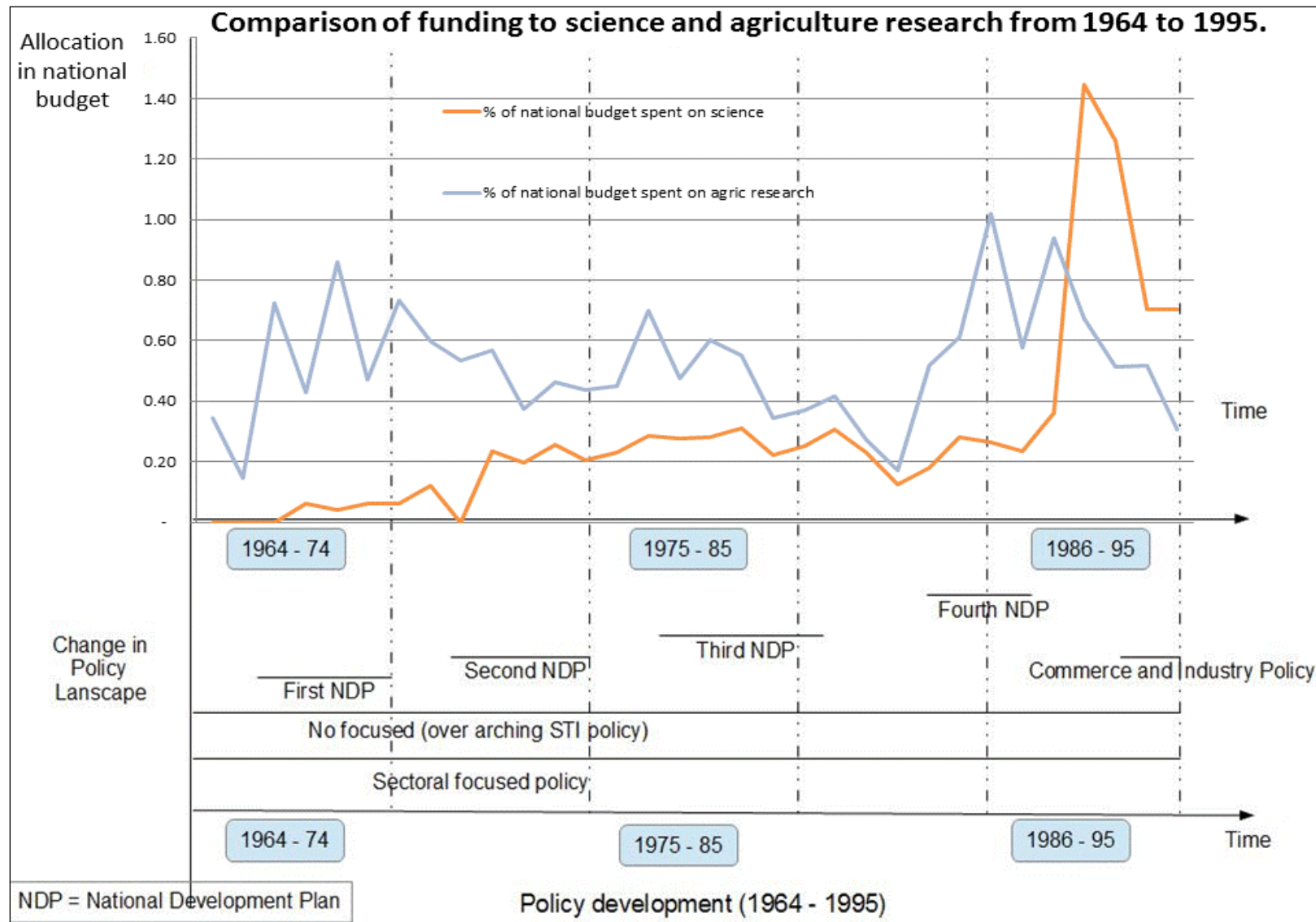


Figure 51: Funding to science and agriculture research from 1964 to 1995

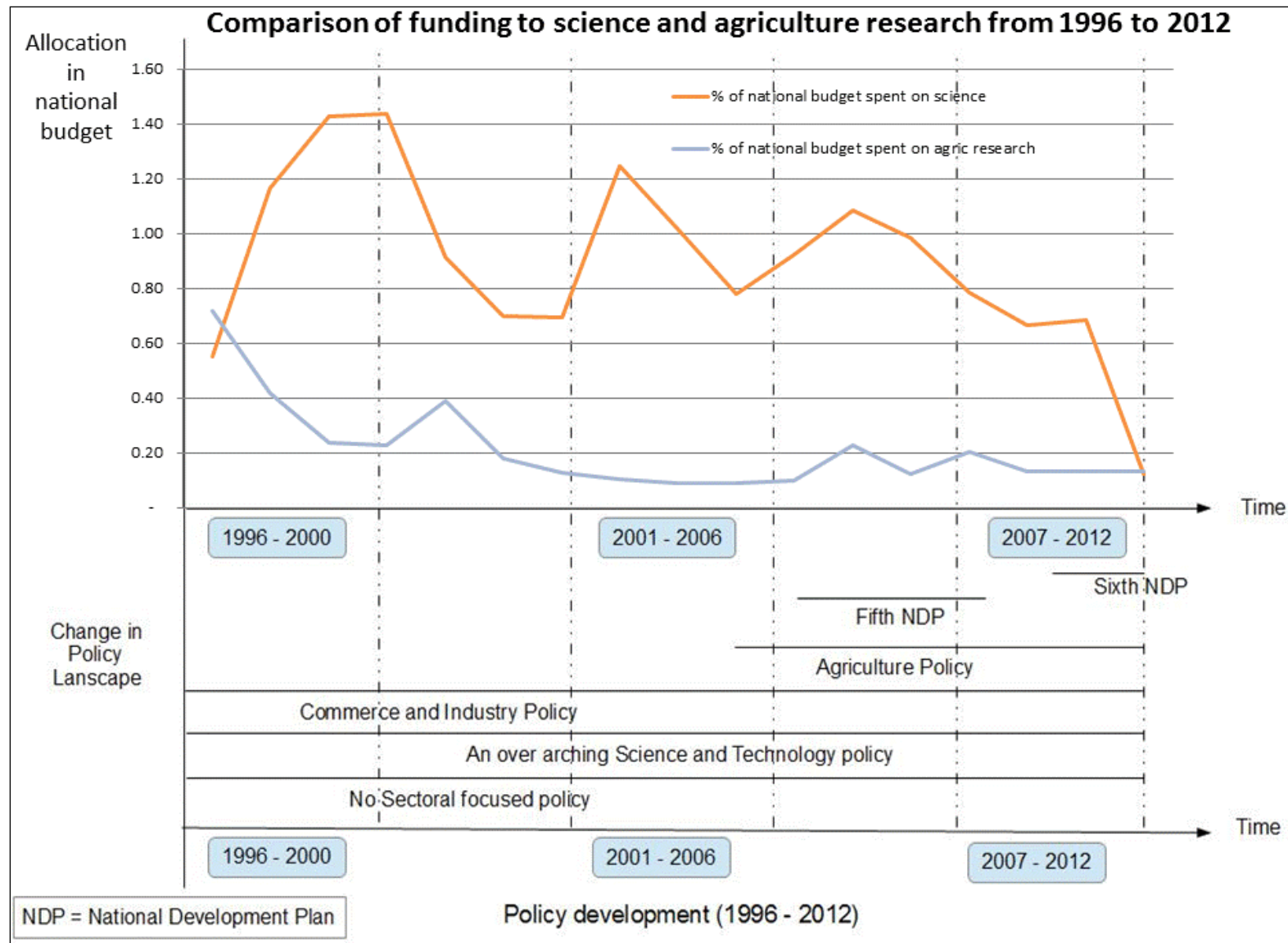


Figure 52: Funding to science and agriculture research from 1996 to 2012

Figure 52 shows the amount spent on science and agriculture research from 1996 to 2012. The amount spent on science research as a percentage of the national budget fell between 0.5% and 1.45, however the graph overall shows a steady decline in funding towards science research in this sector. The largest percentage of the national budget was seen in the years following the launch of the science and technology policy.

The agriculture sector did not fare any better, the graph shows a steady decrease from 0.7% to 0.1% of the national budget being allocated to agriculture research. As in the science research sector studied above, the largest percentage of the national budget was apportioned in the years following the launch of the science and technology policy. The graph also shows a small increase in the years following the launch of the agriculture policy, however this is merely cosmetic as the downward trend of the graph is still apparent. An increase in the allocation was also noticed in the years following the launch of the fifth national development plan.

In terms of the percentage allocation towards research in the science and agriculture sectors the NIS 1964 to 1995 fares better than the NIS 1996 to 2012.

### **6.3 Comparison of amount spent on science in general**

This section will compare the amount spent on the National Council for Scientific Research (NCSR) and the Ministry of Science. Figure 53 shows the graph for the NCSR. The funding to the institution as a percentage of the national budget steadily rose from 0 to slightly over 0.35%. Notable increases were noticed during the second national development plan, and the launch of the commerce and industry policy.

Funding to the Ministry of Science (figure 54) remained constant for the most part. The funding to the Ministry did not fluctuate too much hovering between 0.4% and 1.1%. Notable increases were noticed after the launch of the science and technology policy, and the fifth national development plan.

In terms of the percentage allocation towards science in general the NIS 1996 to 2012 fares better than the NIS 1964 to 1995 as the percentage allocation towards the sector ranges from 0.4% to 1.1%.



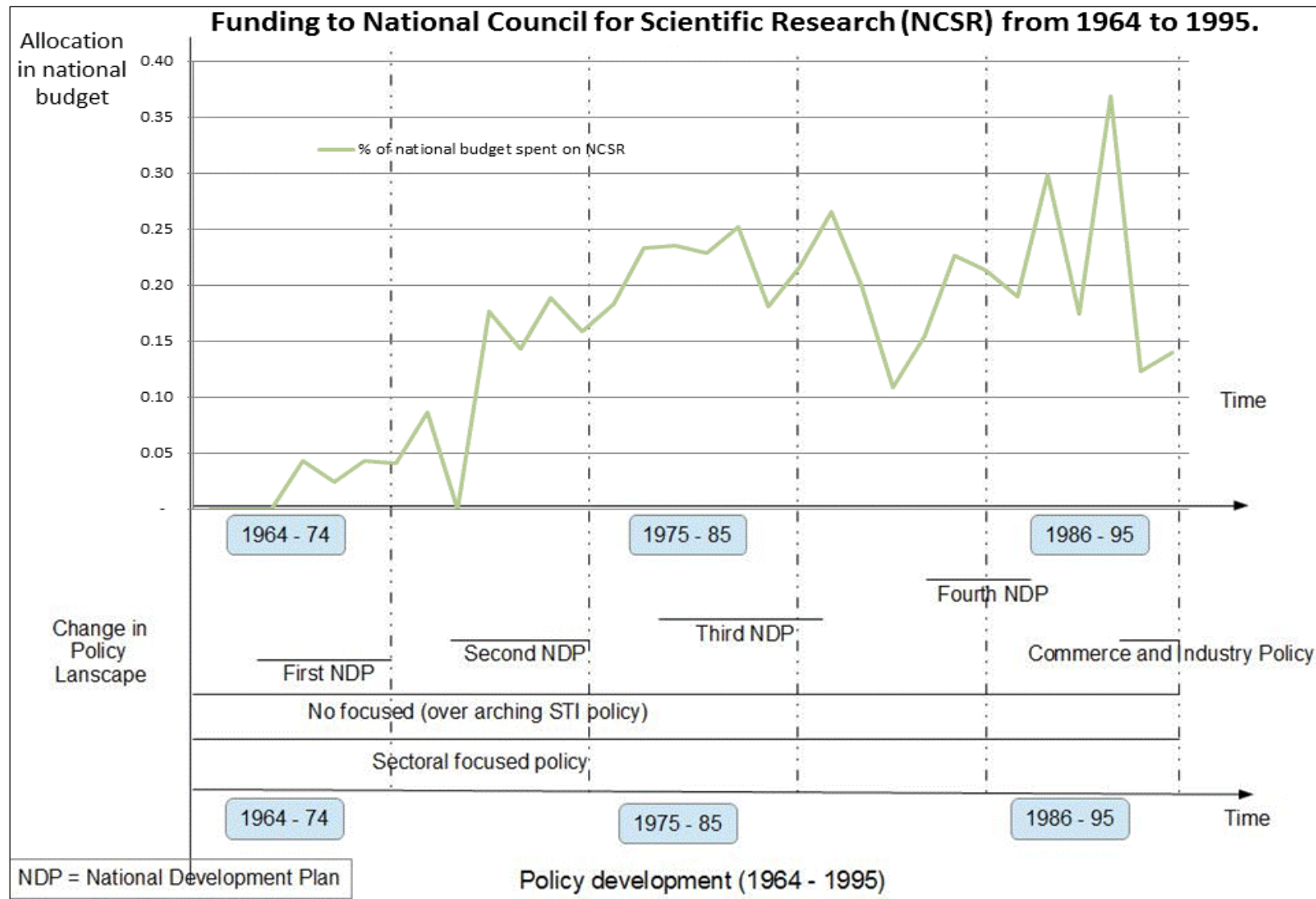


Figure 53: Percentage of national budget allocated to NCSR



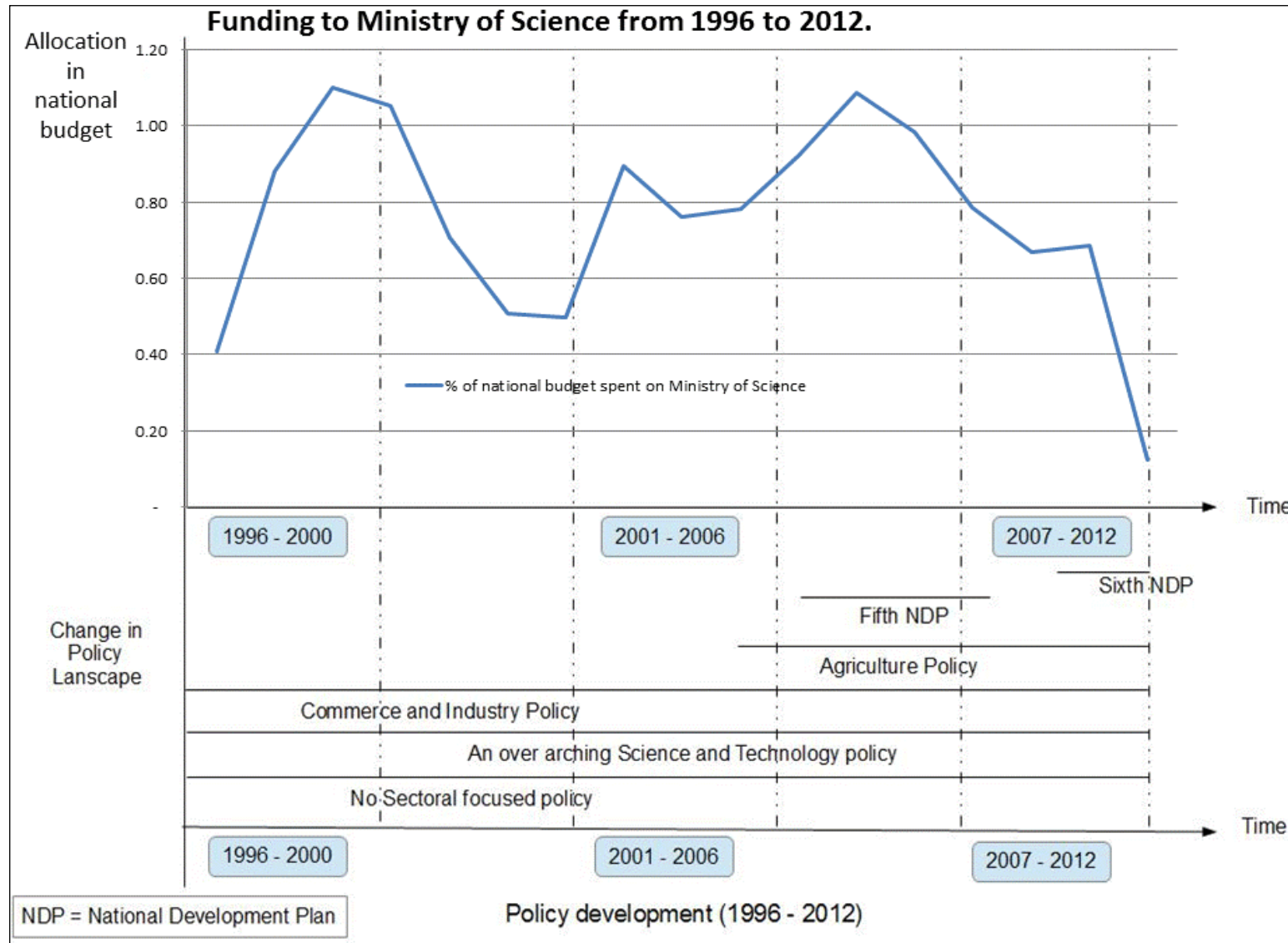
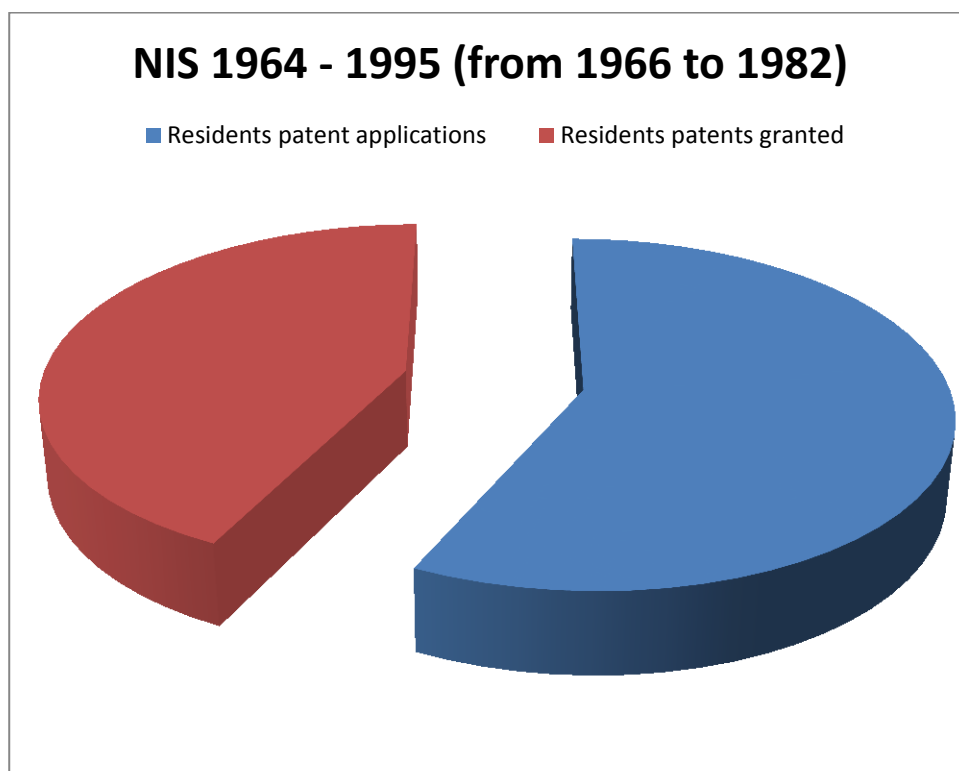


Figure 54: Percentage of national budget allocated to Ministry of Science

#### 6.4 Comparison of patents produced

Patents registered is one of the standard metrics applied in the Science and Technology literature, and therefore a comparison follows below. However, it is important to note that patents registered is a problematic indicator (especially in the case of a peripheral country like Zambia), because in developing context industrial capacity is much more important than rights over designs, and therefore few patents are registered for local markets as the risk of illegal copies is constrained by production capacity of competitors. Therefore patents are important for an international market, in which case the patent will be registered in a central country where the patent can be internationally enforced and not in Zambia. Even so, a comparison of the patents produced in the two eras are given below.

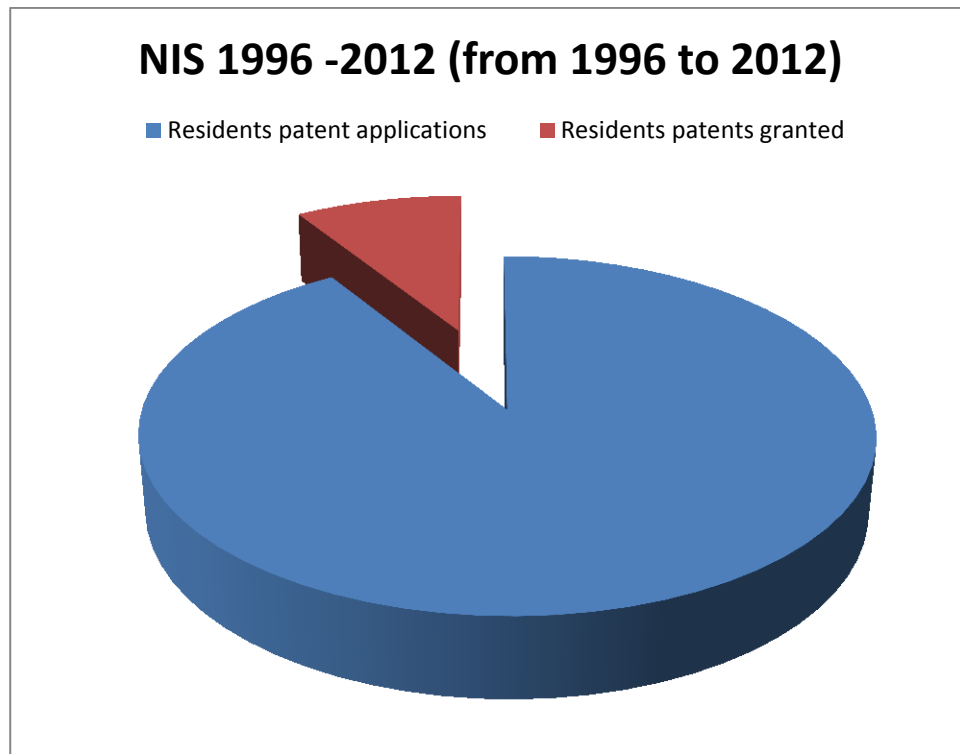
The patents and registry office was formed in 1966, therefore data collected begins in that year. In order to compare the two era's patent data from 1966 to 1982 and 1996 to 2012 is shown in the graphs below. This represents a time span of 17 years for both.



**Figure 55: Pie chart showing Patent applications versus patents granted from 1966 to 1982. Source: WIPO Statistics Database.**

The chart above shows that of a total of 32 applications received a total of 24 were granted which represents 75%. In comparison the chart below shows that in the same time frame 102 patent applications were received and only 10 were granted which represents 9.8%.

In terms of the patents produced the NIS 1964 to 1995 fares better than the NIS 1996 to 2012 as 75% of the patents were approved in comparison to 10%, although the number of applications was much less (32 to 102).



**Figure 56: Pie chart showing Patent applications versus patents granted from 1996 to 2012. Source: WIPO Statistics Database.**

### 6.5 Comparison of exports

The NIS 1964 to 1995 exported mainly agriculture products without much value addition. In comparison during the NIS 1996 to 2012 the country exported more products with value addition. Goods exported from 1964 to 1995 include groundnuts, tobacco, cotton lint, timber, maize with little to no value addition. Goods exported with value addition include cane sugar, cement, parquet blocks and cotton yarn. The country's earnings rose to \$30,000,000.00, with a steep increase seen in tobacco, cotton yarn and cement during the fourth national development plan.

The period 1996 to 2012 saw the variety of goods exported increase and the value rose to over \$250,000,000.00. The goods exported include soya beans, tobacco, maize, cotton lint and coffee with no value addition. In contrast to the previous period the country exported copper wire, electricity, roses, fresh flowers, electrical cables, cement, stock feeds, maize flour and cane sugar.

The country fared better in terms of exports in the NIS 1996 to 2012 than the NIS 1964 to 1995.

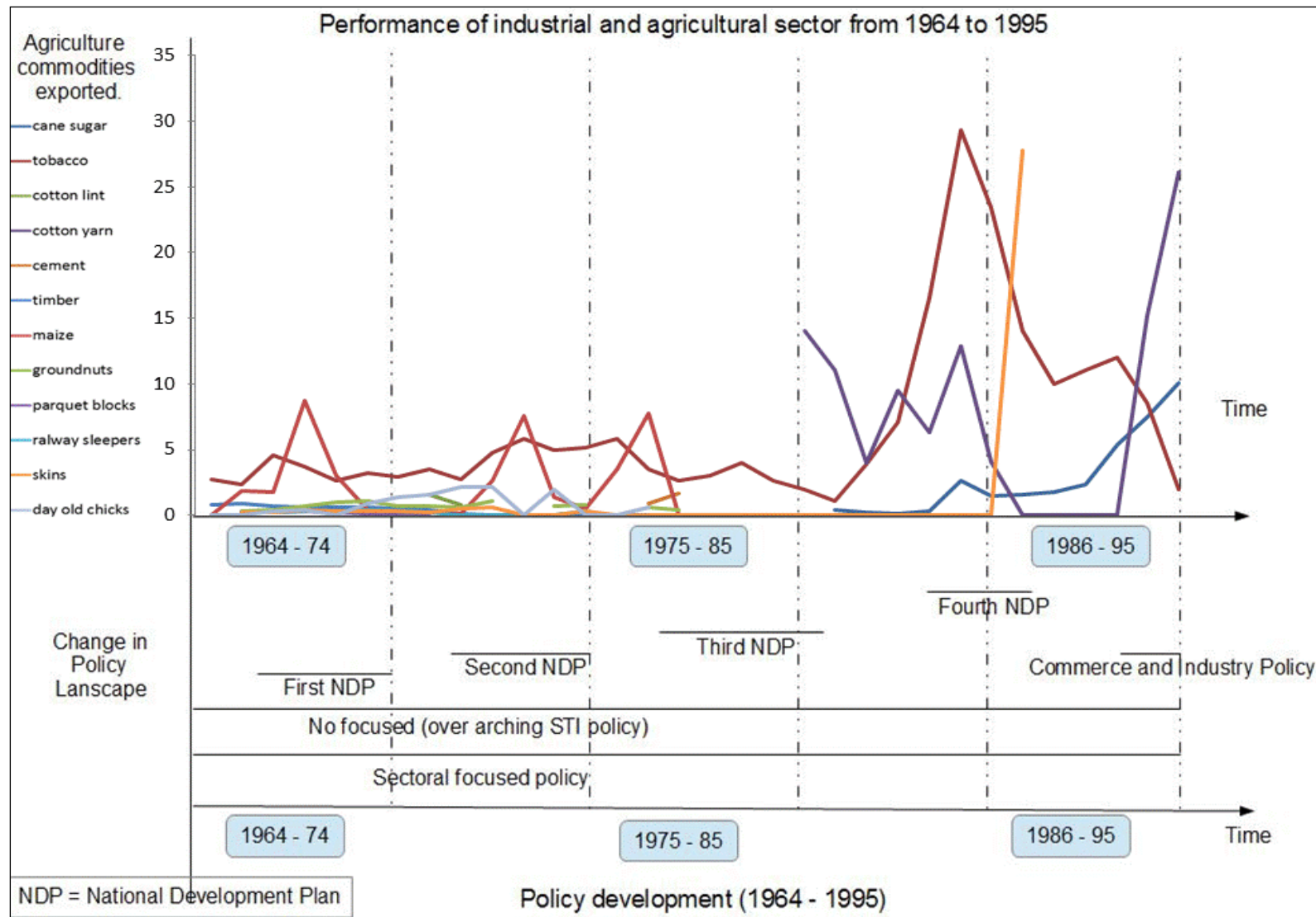


Figure 57: NIS 1964 to 1995 showing goods exported and the policy landscape.

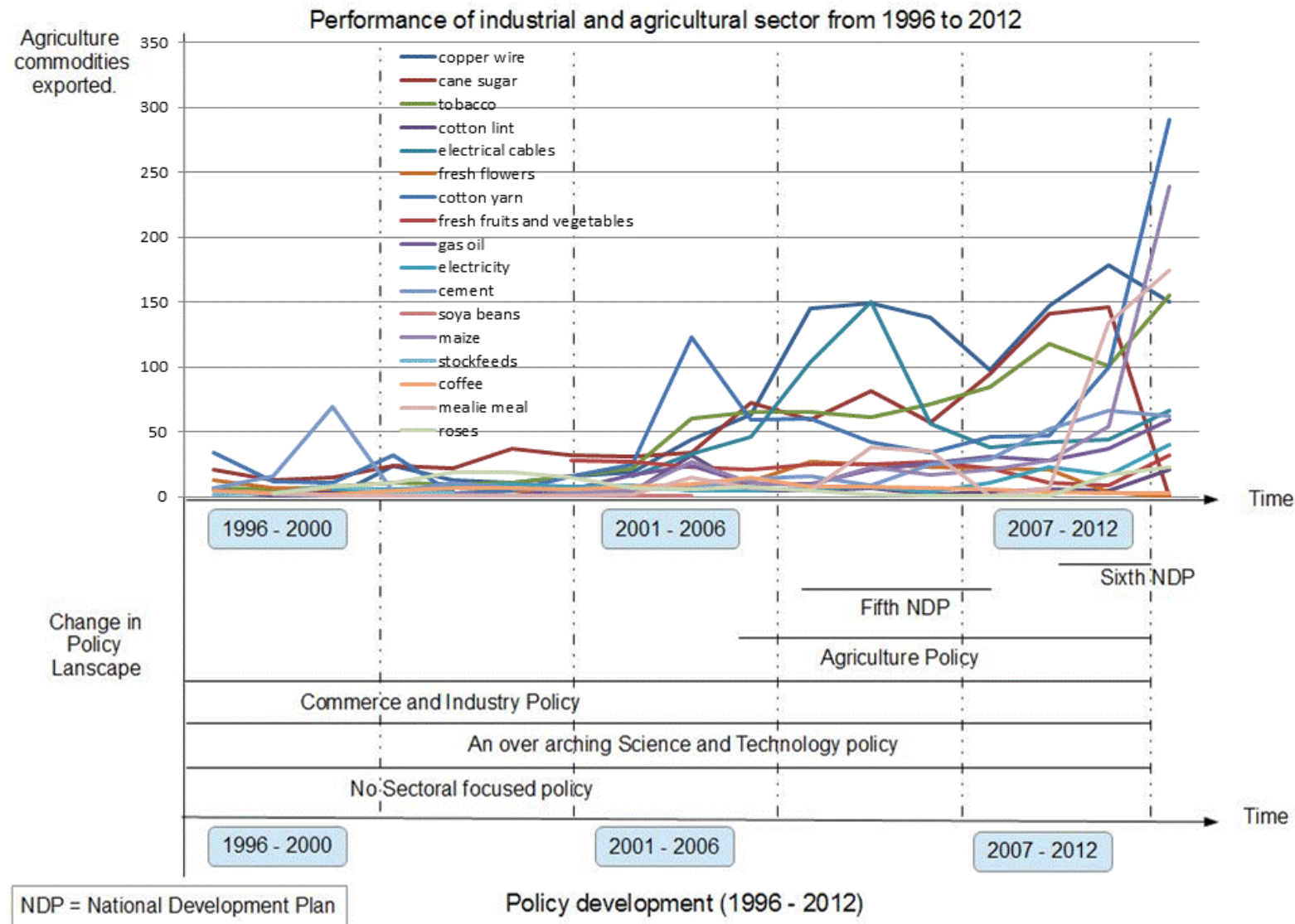


Figure 58: NIS 1996 to 2012 showing goods exported and the policy landscape.

# *Chapter Seven*

## Conclusion

Using Linsu Kim's adapted model to compare the indicators, it has been found that the amount allocated for research in the national budget for the agriculture and science sectors was greater in the NIS that spanned 1964 to 1995 than the NIS that spanned 1996 to 2012. This could be because the national development plans emphasised agriculture as the main area for diversification of the economy and research centres were to come up with crop varieties that would increase harvests. In comparison no national plan existed in the later NIS, however policies that drove the sectors were not able to influence budgetary allocations in the same way.

The amount allocated towards science in general was greater in the NIS that spanned 1996 to 2012 than the NIS that spanned 1964 to 1995. This could be because more institutions existed under this system; it included the National Science and Technology Council (NSTC), the National Technology Business Centre (NTBC), the National Institute for Scientific and Industrial Research (NISIR), and later the National Remote Sensing Centre (NRSC). All the institutions received a maximum of 1.1% of the national budget which amounts to 0.3% if divided equally. It should also be noted that with the splitting of the functions of the National Council for Scientific Research (NCSR), it was possible to tell how much funding went to research institutions and to regulation of research under the science sector.

In addition, it is also possible to see that after the launch of each development plan the appropriation improved. In comparison, an increase in the allocation to the sectors was only noticed after the launch of a policy, then, the percentage allocation steadily waned. Small increases in the budgetary allocation were noticed after the launch of the fifth and sixth national development plans.

The comparison of patents showed that patents produced in the NIS 1964 to 1995 fared better than the NIS 1996 to 2012 as 75% of the patents were approved in comparison to 10%, however the total number of patent applications was far greater for NIS 1996 to 2012 (102)

than for NIS 1964 to 1995 (32). It should also be noted that the funding towards research in the period 1996 to 2012 showed a steady decline therefore it follows that patents granted would also show a decline from 24 to 10.

Comparing the two systems shows that the NIS of 1964 to 1995 has some merits. It was able to influence the amount allocated to the science sector much better as evidenced in the amount given towards research in both the agriculture and science research. It had a greater input in the national development plans. Products that were developed through research were easily transferred to industry (e.g. Tip-Top, and Tarino - they were carbonated drinks). However it should be noted that the NCSR operated in a command driven economy where all industry belonged to the public. The government ran research centres, industries and shops making the transfer of products fairly easy. With the change of the country to a market driven economy, in 1991, the link to industry drastically changed as almost all industries were eventually privatised.

The NIS 1996 to 2012 reflects the shift in government policy. With the change it was possible to tell how much is going to actual research as the government set up various research funds; for example the Science Technology Development Fund and the Strategic Research Fund with the aim that budgetary allocations towards research institutions would go to emoluments, building maintenance and general administration while the amount allocated to research funds would be used to specifically fund research projects. Research institutions were to apply for the funds and projects would be chosen based on merit. However, the NIS 1996 to 2012 could not greatly influence the amount allocated to research institutions, and to the science sector as a whole as the sector saw a steady decline in the appropriations received. In addition the placing of NSTC (which managed the funds) under a ministry meant that it reported to a Permanent Secretary and therefore could not tell ministries not to apply for research grants directly from treasury.

It has been observed that both innovation systems had merits and demerits and combining the strengths of the two systems for the third NIS would see a much more resilient system. The strengths and weaknesses of the two eras can be summarised as follows:

The National Innovation System from 1964 to 1995 had a number of strengths. Firstly, the institution tasked with regulating the sector (NCSR) was able to influence the amount received and the activities undertaken. This was because research institutions applied to NCSR for funding regarding their research activities. Secondly, the NCSR was able to



influence policy making during the development of the national development plans. In contrast, its weaknesses were that, firstly the NCSR carried out research activities as well as the disbursement of funds. During times of scarcity the NCSR favoured in house research to external research. Secondly, it was unable to work closely with the private sector as in the act under which the NCSR was formed, all business where state owned. An advantage to that was that it made technology transfer easier.

The strengths of the National innovation system from 1996 to 2012 were that firstly it is able to work more closely with the private sector and act as a conduit for research innovations. Secondly, two research funds were set up, namely the Strategic Research Fund and the Youth Innovation Fund. The weaknesses of the system were that firstly, the institution tasked with regulating the sector (NSTC) found it difficult to influence the amount received and the activities under taken for institutions that were not under the Ministry of Science. Secondly, every public research institution could lobby central government for funds to carry out research. This led to duplication of effort. Thirdly, the research funding mechanism was fragmented as it was mainly done through the line ministries. This also led to institutions not heeding the call to collaborate by the regulator - NSTC.

A more robust National Innovation System could conceivably incorporate the following elements: The institution that will regulate research in the new policy would have to move to a higher office. This would also have the added benefit of ensuring that research institutions listened to the regulator in terms of what work to carry out and collaboration. Funding provided for research only through the two research funds including the funds from non-governmental organisations or private sector: thereby being able to tell how much is spent on research alone.

Using the adapted model to compare exports, it can be noted that the value of exports steadily rose from \$300,000 to over \$250,000,000.00 in non-traditional exports, in addition the country began exporting more varied products like electricity, and stock feeds. Value addition was noted in products like maize to mealie meal, coffee beans to coffee and cotton lint to cotton yarn; furthermore products like roses and fresh flowers show the use of agricultural technology. It has been shown that industries are learning and are adding value to raw materials, however the monetary value received from non-traditional exports is still small in comparison to that received from the mining sector. The country is still heavily dependent on the mining sector for revenues.

Despite the positive trend, the aims of the national development plans remain largely unrealised. That is, an improvement in the livelihoods of the people in the rural areas through agriculture, making agriculture products the main export earnings for the country and to grow the manufacturing sector through import substitution still remains unrealised. The data shows that little to no impact has been made by the policies in those areas.

Though most of the industries above claim to be exporting their products to the region on their websites, nothing could be found in the Central Statistics Office publications to support this. In addition, though Zambia does seem to be exporting more products with value addition and that industries are creating more varied products, the following questions need further research: Are the industries using local materials or are they importing to create their products? Do the industries have research departments or do they get their innovations from some where else?

The data shows Zambia is moving from an exporter of raw materials to an exporter of finished goods, albeit at a very slow pace. In the context of Linsu Kim's model (figure 6), the country is at a stage of acquisition of technologies as can be seen from the goods exported, e.g. stock feeds, copper wire, electricity and cement. In order to determine if industries are assimilating and making improvements (i.e. learning) more research would have to be carried out.

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